PART 1 - GENERAL

1.1 IMPOSED REGULATIONS
A. Applicable provisions of the State and Local Codes and of the following codes and standards in addition to those listed elsewhere in the specifications are hereby imposed on a general basis for electrical work: codes and standards listed on the electrical drawings.

1.2 SCOPE OF WORK
A. Provide all labor, materials, equipment and supervision to construct complete and operable electrical systems as indicated on the drawings and specified herein. All materials and equipment used shall be new, undamaged and free from any defects.

1.3 RELATED DOCUMENTS AND OTHER INFORMATION
A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the portions of work specified in each and every Section of this Division, individually and collectively.

1.4 EXISTING SERVICES AND FACILITIES
A. Damage to Existing Services: Existing services and facilities damaged by the Contractor through negligence or through use of faulty materials or workmanship shall be promptly repaired, replaced, or otherwise restored to previous conditions by the Contractor without additional cost to the Owner.
B. Interruption of Services: Interruptions of services necessary for connection to or modification of existing systems or facilities shall occur only at prearranged times approved by the Owner. Interruptions shall only occur after the provision of all temporary work and the availability of adequate labor and materials will assure that the duration of the interruption will not exceed the time agreed upon.
C. Removed Materials: Existing materials made unnecessary by the new installation shall be stored on site. They shall remain the property of the Owner and shall be stored at a location and in a manner as directed by the Owner. If classified by the Owner's authorized representative as unsuitable for further use, the material shall become the property of the Contractor and shall be removed from the site at no additional cost to the owner.

1.5 PRODUCT WARRANTIES
A. Provide manufacturer's standard printed commitment in reference to a specific product and normal application, stating that certain acts of restitution will be performed for the Purchaser or Owner by the manufacturer, when and if the product fails within certain operational conditions and time limits. Where the warranty requirements of a specific specification section exceeds the manufacturer's standard warranty, the more stringent requirements will apply and modified manufacturer's warranty shall be provided. In no case shall the manufacturer's warranty be less than one (1) year.

1.6 PRODUCT SUBSTITUTIONS
A. General: Materials specified by manufacturer's name shall be used unless prior approval of an alternate is given by addenda. Requests for substitutions must be received in the office of the Architect at least 10 days prior to opening of bids.

1.7 ELECTRICAL DRAWINGS
A. Electrical contract drawings are diagrammatic and indicate the general arrangement of electrical equipment. Do not scale electrical plans. Obtain all dimensions from the Architect's dimensioned drawings and field measurements. The Contractor shall review Architectural plans for door swings and built-in equipment; conditions indicated on those plans shall govern for this work.

B. Coordinate installation of electrical equipment with the structural and mechanical equipment and access thereto. Coordinate exterior electrical work with civil and landscaping work.

C. Discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions shall be installed to provide the better quality or greater quantity of work; or, comply with the more stringent requirement; either or both in accordance with the A/E’s interpretation.

1.8 SYSTEMS REQUIRING ROUGH-IN

A. Rough-in shall consist of all outlet boxes/raceway systems/supports and sleeves required for the installation of cables/devices by other Divisions and by the Owner. It shall be the responsibility of this Contractor to determine the requirements by reviewing the contract documents and meeting with the Superintendent of the trade involved and Owner’s representative to review submittal data, shop drawings, etc.

B. Sealing of all sleeves, to meet the fire rating of the assembly, whether active or not, is work of this Division.

1.9 SUBMITTALS

A. Refer to section 260510

PART 2 - PRODUCTS

2.1 FIRESTOPPING:

A. A firestop system shall be used to seal penetrations of electrical conduits and cables through fire-rated partitions per NEC 300.21. The firestop system shall be qualified by formal performance testing in accordance with ASTM E-814, or UL 1479.

B. The firestop system shall consist of a fire-rated caulk type substance and a high temperature fiber insulation. It shall be permanently flexible, waterproof, non-toxic, smoke and gas tight and have a high adhesion to all solids so damming is not required. Only metal conduit shall be used in conjunction with this system to penetrate fire rated partitions. Install in strict compliance with manufacturer's recommendations. 3M or approved equal.

C. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

D. Comply with BICSI TDMM, "Firestopping Systems" Article.

PART 3 - EXECUTION

3.1 PRODUCT INSTALLATION, GENERAL

A. Except where more stringent requirements are indicated, comply with the product manufacturer's installation instructions and recommendations, including handling, anchorage, assembly, connections, cleaning and testing, charging, lubrication, startup, test operation and shut-down of operating equipment. Consult with manufacturer's technical experts, for specific instructions on unique product
conditions and unforeseen problems.

B. Protection and Identification: Deliver products to project properly identified with names, models numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged or protected to prevent deterioration during shipment, storage and handling. Store in a dry, well ventilated, indoor space, except where prepared and protected by the manufacturer specifically for exterior storage.

C. Permits and Tests: Provide labor, material and equipment to perform all tests required by the governing agencies and submit a record of all tests to the Owner or his representative. Notify the Architect five days in advance of any testing.

D. Install temporary protective covers over equipment enclosures, outlet boxes and similar items after interiors, conductors, devices, etc. are installed, to prevent the entry of construction debris and to protect the installation during finish work performed by others. Do not install device plates, equipment covers or trims until finish work is complete.

E. Clean all equipment, inside and out, upon completion of the work. Scratched or marred surfaces shall be touched-up with touch-up paint furnished by the equipment manufacturer.

F. Replace all equipment and materials that become damaged.

G. No more than three phase conductors, each of opposite phases for a three phase WYE system, shall be combined in a single raceway unless written approval is granted by the engineer or noted otherwise on the construction documents. (120 volt and 277 volt receptacle and lighting circuits are exempt from this requirement, but must meet the requirements of the NEC)

3.2 EQUIPMENT PROTECTION

A. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.

B. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Equipment shall include but not be limited to motor controllers, enclosures, controllers, circuit protective devices, cables, wire, light fixtures, electronic equipment, and accessories.

C. During installation, equipment shall be protected against entry of foreign matter; and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.

D. Damaged equipment shall be, as determined by the Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.

E. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.

F. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

END OF SECTION 260500
SECTION 260501 - ELECTRICAL DEMOLITION

PART 1 - GENERAL
1.1 Not Used

PART 2 - PRODUCTS
2.1 Not Used

PART 3 - EXECUTION
3.1 EXAMINATION
   A. Field verify measurements and circuiting arrangements are as shown on Drawings.
   B. Verify that abandoned wiring and equipment serve only abandoned facilities.
   C. Demolition drawings are based on casual field observation.
   D. Report discrepancies to Engineer before disturbing existing installation.
   E. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION
   A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
   B. Provide temporary wiring and connections to maintain existing systems in service during construction.
   C. When work must be performed on energized equipment or circuits, use personnel experienced in such operations, submit verification of compliance with the contractor’s safety procedures to the Architect, and notify the Owner in writing a minimum of 24 hours prior to work.
   D. Existing Fire Alarm System: Maintain existing system in service.
   E. The existing television, telephone, computer data, intrusion detection and intercom system shall remain operable during construction. Plan and execute the work accordingly. Provide temporary wiring and facilities as may be required.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK
   A. Maintain electrical service to areas outside of the construction area.
   B. Remove, relocate, and extend existing installations to accommodate new construction.
   C. Remove abandoned wiring to source of supply.
   D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
   E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
   F. Repair adjacent construction and finishes damaged during demolition and extension work.
G. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

H. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

I. Remove all abandoned conductors and cables within the construction area.

J. Support all existing communication cables within the construction area.

K. Provide fire stopping for all existing communication conduit fire rated wall penetrations within the construction area.

3.4 CONSTRUCTION PHASING

A. Plan and execute the work in accordance with the construction phasing indicated on the Architectural plans. Test and certify all systems, by phase of construction, so that "partial occupancy" can be obtained.

3.5 REUSE OF EXISTING MATERIALS

A. Where new devices are to replace existing, it shall be permissible to reuse existing outlet boxes and branch circuit conduits. It shall be the responsibility of the Contractor to ensure that existing outlet boxes and conduits that are reused comply with requirements for new.

B. The reuse of conduits (not remaining in place), conductors, and devices is not permitted.

3.6 CUTTING AND PATCHING

A. Structural Limitations: Do not cut structural framing, walls, floors, decks, and other members intended to withstand stress, except with the Engineer’s written authorization. Authorization will be granted only when there is no other reasonable method for completing the electrical work, and where the proposed cutting clearly does not materially weaken the structure.

B. Cutting Concrete: Where authorized, cut openings through concrete (for conduit penetrations and similar services) by core drilling or sawing. Do not cut by hammer-driven chisel or drill. Prior to cutting of existing concrete walls, floors, or ceilings x-ray existing concrete to locate existing hidden utilities.

C. Other Work: Do not endanger or damage other work through the procedures and process of cutting to accommodate electrical work. Review the proposed cutting with the Installer of the work to be cut, and comply with his recommendations to minimize damage. Where necessary, engage the original Installer or other specialists to execute the cutting in the recommended manner.

D. Patching: Where patching is required to restore other work, because of cutting or other damage inflicted during the installation of electrical work, execute the patching in the manner recommended by the original Installer. Restore the other work in every respect, including the elimination of visual defects in exposed finished, as judged by the Engineer. Engage the original Installer to complete patching of various categories of work including: concrete and masonry finishing, waterproofing and roofing, exposed wall finishes, etc.

3.7 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or that are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged...
circuit breakers and provide closure plates for vacant positions.

3.8 LABELING

A. Provide typed circuit directory showing revised circuiting arrangement.

B. Provide and install a new engraved nameplate for all electrical panels that have been modified during construction.

END OF SECTION 260501
SECTION 260502 - ELECTRICAL ACCEPTANCE TESTS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 260510.

1.2 References


1.3 SCOPE OF WORK

A. Acceptance tests shall be performed in accordance with the current version of ASNI/NETA ATS and by an independent testing agency.

B. Tests shall be performed in accordance with applicable codes, standards, and equipment manufacturers' instruction.

C. The Contractor shall provide all test equipment, materials and labor necessary to perform the tests, and shall coordinate with the other trades for necessary services, such as scaffolding and the uncoupling of motors.

D. Tests shall consist of visual inspections, manual operations, and electrical testing under all normal and expected abnormal operating conditions.

E. The Owner shall be notified at least 2 weeks in advance of all tests.

F. Tests shall be witnessed by the Engineer unless such witnessing is waived in writing.

G. The Engineer shall be provided with a written test report, signed and dated, for all tests.

H. Acceptance testing shall be provided and reviewed by the Engineer prior to energizing of electrical equipment. Phasing may require multiple trips/tests/reports and after hours work.

1.4 TESTING CRITERIA

A. High potential tests shall be performed at the AC or DC voltage listed in ASNI/NETA ATS unless specified otherwise herein. Do not perform more than one high potential test on any item without authorization from the Owner.

B. Dielectric absorption tests shall be performed with a 2,500 volt DC megger.

C. Megger tests shall be performed at a DC voltage of 1,000 volts for 600 volt rated equipment, and at a DC voltage of 500 volts for 120-300 volt rated equipment.

D. Continuity checks shall be performed with a low voltage DC meter, light or bell.

E. The resistance to ground shall be measured using either the three point method or the fall of potential method.

F. Test instruments shall be calibrated to national standards to ensure the accuracy of tests. These calibration reports shall be made available to the Owner when requested. Depending upon frequency of use, the instruments shall be calibrated at least every 12 months.
PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 VISUAL INSPECTIONS

A. Prior to manual operation and electrical testing, verify the following:
   1. The equipment is free from damage and defects.
   2. The equipment has been lubricated.
   3. The ventilation louvers are open and unobstructed.
   4. Electrical connections have been tightened.
   5. Voltages, phases, and rotation have been identified.
   6. Terminations have been identified.
   7. Equipment labels have been installed.
   8. The equipment has been calibrated.
   9. The equipment is ready to be electrically tested

3.2 MANUAL OPERATIONS

A. Prior to electrical testing, verify the following:
   1. Mechanical components operate smoothly and freely.
   2. Mechanical stops, limit switches, etc., are properly adjusted.

3.3 ELECTRICAL ACCEPTANCE TESTS

A. Duct Banks
   1. A stiff bristled brush shall be pulled through each duct to clean out dirt and debris.
   2. A solid mandrel rated for the inside diameter of the ducts and at least 5 inches long shall be
      pulled through each duct to verify the absence of kinks, flat spots, and other obstructions.

B. 600 Volt Power Cables
   1. A continuity check and a 1,000 volt DC megger test shall be performed on 600 volt power
cables No. 4 AWG and larger. The megger test shall be performed between each pair of
conductors and from each conductor to ground. Each test shall be performed for 15 seconds
or until the insulation resistance value stabilizes.
   2. The insulation resistance between conductors, and from each conductor to ground, shall be
   100 megohms minimum in one minute or less. In addition, the lowest insulation resistance
   value shall not differ from the highest value by more than 20 percent. If all megger readings
   for a given circuit are above 1000-meghoms, the 20 percent balance requirement may be
   waived.
   3. Proper rotation shall be verified.

C. Panelboards and Motor Control Equipment
   1. A continuity check and a 1,000 volt DC megger test shall be performed on distribution and
   isolation transformers, and on line reactors.
   2. A 1,000 volt DC megger test shall be performed on buses, motor starters, circuit breakers, and
disconnect switches. This test may be combined with the power cable megger test by testing
the devices and terminated cables together.
   3. A continuity check shall be performed on motor control circuits and control panel internal
   wiring.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance,
perform an infrared scan of each ATS switch, panels, switchboards, switchgear, transformers, motor
starters, DSTS, and enclosed Bus. Remove all access panels so joints and connections are accessible to
1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2. 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.

END OF SECTION 260502
SECTION 260510 – ELECTRICAL SUBMITTALS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with the applicable requirements of the Division 1 specifications (013300) and the requirements of this Division of the specifications.

1.2 SUBMITTALS

A. Submit for review by the Engineer Architect a schedule with engineering data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive materials, i.e., catalog sheets, product data sheets, diagrams, performance curves and charts published by the manufacturer, warranties, etc., to show conformance to Specifications and Plan requirements; model numbers alone shall not be acceptable. Data submitted for review shall contain all information to indicate compliance with Contract Documents. Complete electrical characteristics shall be provided for all equipment. Submittals for lighting fixtures shall include Photometric Data. The Engineer reserves the right to require samples of any equipment to be submitted for review.

B. The purpose of shop drawing review is to demonstrate to the Architect that the Contractor understands the design concept. The Architect's review of such drawings, schedules, or cuts shall not relieve the Contractor from responsibility for deviations from the drawings or specifications unless he has, in writing, called the Architect's attention to such deviation at the time of submission, and received written permission from the Architect for such deviations.

C. Where cut sheets include an entire product family, mark all specific items to be utilized for this project on equipment cut sheets. Generic cut sheets with no indication of which items on the cut sheet shall be used will be rejected.

D. Response to Submittals: Shop drawings shall be stamped and signed by the Electrical Engineer with the following classifications:

E. "No Exceptions Taken": No corrections, no marks. Contractor shall submit copies for distribution

F. "Make Corrections Noted": A few minor corrections. Items may be ordered as marked up without further resubmission. Submit copies for distribution.

G. "Amend and Resubmit": Minor corrections. Item may be ordered at the Contractor's option. Contractor shall resubmit drawings with corrections noted.

H. "Rejected - Resubmit": Major corrections or not in accordance with the contract documents. No items shall be ordered. Contractor shall correct and resubmit drawings.

I. Prior Approvals and Shop Drawings must be hand delivered, received by mail, or email.

J. Submittal data received by facsimile will not be reviewed.

K. Equipment and materials requiring submittals:
   1. Section 260500 – Common Work Results for Electrical
      a. Product Warranties
      b. Firestopping Materials
      c. Firestopping Installation Drawings for each conduit penetration, cable in metal sleeve penetration and blank metal sleeve penetration for each type of wall/floor construction
encountered.

2. Section 260502 – Electrical Acceptance Tests
   a. Test Reports
   b. Testing Company Qualifications.

3. Section 260511 – Electrical Work Closeout
   a. Record Drawings
   b. Record Manuals
   c. Close out submittals
   d. Training verification

4. Section 260512 – Electrical Coordination
   a. Coordination Affidavit

5. Section 260519 – Low-Voltage Electrical Power Conductors and Cables
   a. Splice Kits
   b. Waterproof Wire Connectors
   c. Wire
   d. Field Quality Control Test Reports

6. Section 260526 – Grounding and Bonding for Electrical Systems
   a. Grounding Rods
   b. Grounding Connections
   c. Ground Wire
   d. Field Quality Control Test Reports
   e. Bonding Bushings
   f. Bonding Jumper Braid
   g. “Water Valve” Enclosures
   h. Ground Buss Bars

7. Section 260529 – Hangers and Supports for Electrical Systems
   a. Product Data

8. Section 260533 – Raceway and Boxes for Electrical Systems
   a. Raceway
   b. Boxes
   c. Enclosure ratings
   d. Dimension data
   e. Corrosion Protection
   f. Surface Metallic/Nonmetallic Raceway
   g. Cast Outlet/Device Boxes

9. Section 260543 – Underground Ducts and Raceways for Electrical Systems
   a. Raceway
   b. Handholes
   c. Warning Tape

10. Section 260548 – Vibration and Seismic Controls for Electrical Systems
    a. Submit seismic force level (Fp) calculations from applicable building code.
    b. Submit pre-approved restraint selections and installation details
    c. Restraint selection and installation details shall be sealed by a professionally licensed
        engineer experienced in seismic restraint design.
    d. Submit manufacturer's product data on strut channels including, but not limited to, types,
materials, finishes, gauge thickness, and hole patterns. For each different strut cross-
section, submit cross sectional properties including Section Modulus (Sx) and Moment of
Inertia (Ix).
e. Field reports

11. Section 260553 – Identification for Electrical Systems
   a. Product data for all labeling products
   b. Samples of device name plates

12. Section 260574 – Short Circuit, Overcurrent Protection, Arc Flash Hazard Analysis
   a. Provide study per specification.

13. Section 262400 – Switchboards and Panelboards
   a. Product data
   b. Enclosures
   c. Dimensional Data
   d. Circuit Directory
   e. Circuit Breaker trip curves
   f. Locks
   g. Shunt-Trip Breakers
   h. Bussing Diagrams
   i. Ground-Fault Protection
   j. Schematic Wiring Diagram
   k. Layout Drawings and elevations
   l. Short Circuit Current Rating

14. Section 262726 – Wiring Devices
   a. Product data
   b. Device Plates
   c. Weatherproof Covers
   d. Special Purpose Receptacles
   e. Device and device plate colors

15. Section 262813 – Fuses
   a. Fuses

16. Section 262816 – Enclosed Switches and Circuit Breakers
   a. Product data
   b. Enclosures
   c. Dimensional Data
   d. Control Wiring Diagrams
   e. Accessories
   f. Short Circuit Current Rating
   g. Test reports

17. Section 262913 – Enclosed Controllers
   a. Starters
   b. Combination motor controllers
   c. Overload element rating
   d. Control power transformers / ratings
   e. Pilot Lights
   f. Control Devices
   g. Phase Failure Relays
   h. Equipment List
i. Short Circuit Current Rating
j. Motor Rated Switches

18. 263200 – Packaged Generator Assemblies
   a. Engine
   b. Generator
   c. Controller
   d. Instrument Panel
   e. Remote Annunciator Panel
   f. Mounting Base
   g. Fuel Tank
   h. Accessories
   i. Wiring Diagrams
   j. Warranty
   k. Service Agreement
   l. Enclosures
   m. Field test reports

19. 263600 – Transfer Switches
   a. Front view, side view, and plan view of assembly including weights, mounting details, conduit entry provisions.
   b. Schematic diagram including equipment and device arrangement, elementary and interconnection wiring diagrams, and accessories.
   c. Conduit space locations within the assembly.
   d. Assembly ratings including:
      1. Withstand and closing rating
      2. Voltage
      3. Continuous current rating
      4. Short-time rating if applicable
      5. Short-Circuit rating if ordered with integral protection
   e. Cable terminal size.
   f. Product data sheet.
   g. Complete nameplate data.

20. Section 265100 – Interior Lighting
    a. Lighting Fixtures
    b. Drivers
    c. Emergency Batteries
    d. Emergency transfer units
    e. Color Samples

21. Section 283100 – Fire Detection, Alarm, and Mass Notification System
    a. Surge Protection
    b. HVAC/Egress Door/Elevator Recall/Mass Notification Control Wiring Diagrams
    c. Battery calculations.
    d. Voltage drop calculations
    e. Installer’s qualifications.
    f. Conduit fill calculations.
    g. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
    h. Device layout drawings with proposed conduit routing. Drawings must be prepared using AutoCAD Release 2007 or newer.
    i. System riser diagram.
    j. List of all devices on each signaling line circuit, with spare capacity indicated.
k. Clear and concise description of operation, with input/output matrix similar to that shown in 2010 NFPA 72 Appendix A Figure A.14.6.2.4(9).
l. Warranty
m. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions if required to make clarifications or revisions to obtain approval.
n. Inspection and Test Reports:
   1) Submit inspection and test plan prior to closeout demonstration
   2) Submit documentation of satisfactory inspections and tests.
   3) Submit NFPA 72 "Inspection and Test Form," filled out.

PART 2 - PRODUCTS

2.1 Not Used.

PART 3 - EXECUTION

3.1 MANUFACTURER’S DATA

   A. Include the manufacturer's comprehensive product data sheet and installation instructions. Where operating ranges are shown, mark data to show portion of range required for project application. Where pre-printed data sheet covers more than one distinct product-size, type, material, trim, accessory group or other variations, delete or mark-out portions of the pre-printed data which are not applicable.

3.2 EQUIPMENT LIST

   A. Where more than one type of a product is being used (i.e. starters, disconnects, breakers, etc.) provide a list with each submittal correlating the type and size of product to the load served.

3.3 TEST REPORTS

   A. Submit test reports which have been signed and dated by the firm performing the tests, and prepare in the manner specified in the standard or regulation governing the tests procedure as indicated.

END OF SECTION 260510
SECTION 260511 - ELECTRICAL WORK CLOSEOUT

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 260510.

1.2 RELATED SECTIONS

A. Refer to section 017839 for additional requirements.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Except where otherwise indicated, electrical drawings prepared by Engineer are diagrammatic in nature and may not show locations accurately for various components of electrical system. Shop drawings, including coordination drawings, prepared by the Contractor show portions of work more accurately to scale and location, and in greater detail. It is recognized that actual layout of installed work may vary substantially from both Contractor drawings and shop drawings.

B. The electrical superintendent shall maintain a white set of contract documents and shop drawings in clean, undamaged condition, for mark-up of actual installations which vary substantially from the work as shown. PDF or digital mark-ups is acceptable. Mark-up whatever drawings are most capable of showing installed conditions accurately. However, where shop drawings are marked, record a reference note on appropriate contract drawings. Mark with erasable pencil, and use multiple colors to aid in the distinction between work of separate electrical systems. These documents shall be used for no other purpose. In general, record every substantive installation of electrical work which previously is either not shown or shown inaccurately, but in any case record the following:

1. Post all addenda prior to beginning work.
2. Underground feeder conduits, both interior and exterior, drawn to scale and fully dimensioned.
3. Work concealed behind or within other work, in a non-accessible arrangement.
4. Mains and branches of wiring systems, with panelboards and control devices located and numbered, with concealed splices located, and with devices requiring maintenance located.
5. Scope of each change order (C.O.), noting C.O. number.

C. Upon each visit by the Architect/Engineer, the Contractor shall demonstrate that the record documents are being kept current, as specified herebefore.

2.2 RECORD MANUALS

A. Record manuals shall include the following:

1. Manufacturer’s operation and maintenance manuals for:
   a. Light Fixtures
   b. Circuit Breakers
   c. Fire Alarm System

2. Shop drawings, revised to reflect all review comments, supplemented with the installation instructions shipped with equipment.
3. One copy of all panelboard directories.
4. All field test Reports
5. Electrical Contractor’s Warranty
6. Fire alarm set of floor plans showing actual installed locations of components, conduit, and
7. Fire Alarm "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

B. Submit record manuals in quantities and in the format prescribed in the Division 1 specifications.

C. Submit copies of all Maintenance contracts including,
   1. Fire Alarm Systems.

2.3 CLOSEOUT SUBMITTALS

A. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

PART 3 - EXECUTION

3.1 INSPECTIONS

A. At all construction observations by the Architect/Engineer, the Contractor shall demonstrate to the Architect/Engineer that all work is complete in accordance with the contract documents and that all systems have been tested and are fully operational. The Contractor shall furnish the personnel, tools and equipment required to inspect and test all systems.

3.2 TRAINING

A. Train Owner’s personnel on the operation and maintenance of the following systems:
   1. Fire Alarm and Mass Notification System - 4 hours

B. Training shall not be conducted until system has been tested by the Contractor and is 100% operational. Refer to the individual specification sections for additional requirements.

END OF SECTION 260511
SECTION 260512 ELECTRICAL COORDINATION

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 260510.

PART 2 - PRODUCTS

2.1 ELECTRICAL COORDINATION DRAWINGS

A. Electrical Rooms: Provide layouts of all electrical rooms using the dimensions of equipment actually furnished. Locate all ducts and piping entering or crossing these spaces.

B. Feeders over 100 Amps: The routing of main feeders is not shown on the drawings. Actual routing shall be determined by the contractor in accordance with the specifications and shall be coordinated with work by other trades. For underground lines, show all utility crossings.

C. Drawing Format: Drawings shall be prepared at a scale of no less than 1/16"=1'-0" for feeder routes and 1/4"=1'-0" for electrical rooms/equipment yards. Drawing shall be titled to define Project Name, Drawing subject and date prepared. Drawings are to be prepared in AutoCAD 2007 or compatible software.

2.2 EQUIPMENT REQUIRING ELECTRICAL SERVICE

A. Provide electrical connections for all electrically driven equipment. Final connections are electrical work, except as otherwise noted. Obtain a copy of the shop drawings of equipment. Review shop drawings to verify electrical characteristics and to determine rough-in requirements, final connection requirements, location of disconnect switch, etc. Notify the General Contractor if the information received is ambiguous or incomplete. Keep a copy of these shop drawings at the project site throughout the course of construction.

B. Equipment to be connected includes, but is not limited to the following:
   1. HVAC Equipment
   2. Fire Alarm System
   3. Elevators
   4. Telephone/Computer Systems
   5. A/V systems
   6. Control Systems

C. The design of circuits for electrically driven equipment is based on the product of one manufacturer and may not be representative of all acceptable manufacturers. If equipment furnished has differing characteristics, make necessary adjustments to circuit components at no additional cost to the Owner, subject to the approval of the Engineer.

D. Provide motor starters and disconnects for all mechanical equipment unless provided by the mechanical contractor.

PART 3 - EXECUTION

3.1 COORDINATION OF MECHANICAL INSTALLATION:
A. Attachment Number 1 shall be filled out and returned with shop drawing submittals. The intent of Attachment Number 1 is to ensure that the electrical requirements for equipment have been reviewed and coordinated by the Contractor. No electrical equipment shall be ordered, nor shall rough-in begin, before this coordination has taken place. This document shall be returned appropriately marked whether or not any changes are deemed to be necessary by the contractor.
SHOP DRAWING COORDINATION AFFIDAVIT

I, the undersigned, certify that I have reviewed the equipment shop drawings for electrically driven equipment and that the accompanying electrical shop drawings reflect the requirements of the actual equipment to be furnished for use on this project. The following deviations from design drawings were required to serve the furnished equipment:

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<th>BKR.SIZE</th>
<th>CONDUIT/WIRE</th>
<th>DISC.SIZE</th>
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NOTE: If no deviations are required please indicate by circling the appropriate answer above your signature.

PROJECT: _____________________________ DEVIATIONS: Yes / No

COMPANY:________________________________________________________

TITLE: ___________________ SIGNATURE: _________________________

TELEPHONE: __________________DATE: ____________________________

IT IS THE RESPONSIBILITY OF THE DIVISION 26 CONTRACTOR TO OBTAIN SHOP DRAWING INFORMATION FROM OTHER TRADES. FAILURE TO PERFORM THE WORK REQUIRED BY THIS AFFIDAVIT, PRIOR TO ORDERING MATERIALS OR ROUGHING-IN, MAY RESULT IN IMPROPER CONNECTIONS BEING PROVIDED. THE EXPENSE OF CORRECTIVE MEASURES, IF REQUIRED, SHALL BE BORNE BY THE CONTRACTOR.

NOTE:
PANELBOARD SHOP DRAWINGS WILL NOT BE REVIEWED UNTIL THE ELECTRICAL CONTRACTOR COMPLETES AND SUBMITS THIS AFFIDAVIT TO THE ELECTRICAL ENGINEER.

END OF SECTION 260512
SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the requirements for the following:
   1. Wire and cable for 600 volts and less.
   2. Wiring connectors and connections.

1.2 SUBMITTALS

A. Refer to section 260510.

1.3 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 REFERENCE STANDARDS


PART 2 - PRODUCTS

2.1 WIRING REQUIREMENTS

A. Concealed Dry Interior Locations: Use only THHN, THWN-2 or XHHW-2 wire in raceway.

B. Exposed Dry Interior Locations: Use only THHN, THWN-2, or XHHW-2 in raceway.

C. Above Accessible Ceilings: Use only THHN, THWN-2, or XHHW-2 in raceway.

D. Wet or Damp Interior Locations: Use only THWN-2 or XHHW-2 in raceway.

E. Exterior locations (above or below grade) THWN-2, XHHW-2 or USE in raceway.

F. Use conductors not smaller than 12 AWG for power and lighting circuits.

G. Use conductors not smaller than 14 AWG for control circuits.

H. Metal Clad (MC) cable shall not be used.

2.2 BUILDING WIRE

A. Conductor: Copper.
B. Insulation Voltage Rating: 600 volts.

C. Temperature Rating: 90° C.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Pull all conductors into raceway at same time.

B. Use suitable wire pulling lubricant for building wire 4 AWG and larger. Do not exceed manufacturers recommended maximum pulling tensions and sideway pressure values.

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

D. Neatly train and lace wiring inside boxes, equipment, and panelboards.

E. Clean conductor surfaces before installing lugs and connectors.

F. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

G. Use split bolt connectors or compression fittings for splices and taps on conductors 6 AWG and larger. Tape uninsulated conductors and connecter with electrical tape to 150 percent of insulation rating of conductor.

H. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

I. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

J. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values or UL 486A and UL 486B.

K. Identify and color code wire and cable under provisions of Section 260553. Identify each conductor with its circuit number or other designation indicated.

L. For each electrical connection/termination, provide a complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other materials necessary to complete splices and terminations. Torque all connections according to installation instructions.

M. Motor connections shall be made with compression connectors forming a bolted in-line or stub-type connection.

N. Splicing of feeder conductors shall not be acceptable, unless specifically indicated on the drawing. Where splicing of feeder conductors is indicated, splices shall be made using compression type butt splice.

O. All splices made underground or in the pipe basements shall be rated suitable for water immersion.

P. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for cables in riser conduits. Plugs shall have number, size, and
shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

3.2 LABELING

A. Color Coding
   1. Color shall be green for grounding conductors and green with yellow stripe for isolated grounding conductors.
   2. The color of the circuit conductors shall be as follows:

   120/208 volt, 3-phase
   - Phase A - Black
   - Phase B - Red
   - Phase C - Blue
   - Neutral - White

   277/480 volt, 3-phase:
   - Phase A - Brown
   - Phase B - Orange
   - Phase C - Yellow
   - Neutral – Gray

END OF SECTION 260519
SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Grounding and bonding components.

B. Provide all components necessary to complete the grounding system(s) consisting of:
   1. Existing and new metal underground water pipe.
   2. Metal frame of the building.
   3. Steel water storage tank and supports.
   4. Concrete-encased electrode.

1.2 SUBMITTALS

A. Refer to section 260510.

1.3 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.4 REFERENCES


1.5 PERFORMANCE REQUIREMENTS

A. Maximum grounding system resistance: 15 ohms.

B. Services at power company interface points shall comply with the power company ground resistance requirements.

PART 2 - PRODUCTS

2.1 ELECTRODES

A. Sectionalized steel with copper-welded exterior, 3/4" dia. x 10'. One 10-foot section shall be required at each ground rod location, unless as otherwise directed in this specification.

2.2 CONDUCTORS

A. Bonding Jumper Braid: Copper braided tape, sized for application.

B. Electrical Grounding conductors: Unless otherwise indicated, provide bare or green insulated stranded copper electrical grounding conductors sized according to NEC or as shown or specified. Provide green insulated for conductors sized No. 10 AWG and smaller.
2.3 GROUND CONNECTIONS

A. Below Grade: Exothermic-welded type connectors.

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

C. Install exothermic connectors and terminals as recommended by the connector and terminal manufacturer for intended applications.

D. Bolted clamp will not be accepted between grounding rods and ground conductors.

2.4 EQUIPMENT RACK AND CABINET GROUND BARS

A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 3/8 inch x ¾ inch unless noted otherwise.

B. Busbar Connectors: Cast silicon bronze, solderless, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

C. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.

2.5 GROUND TERMINAL BLOCKS

A. At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions prior to beginning work.

B. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 ELECTRICAL AND COMMUNICATION ROOM GROUNDING

A. Building Earth Ground Busbars: Provide ground busbar hardware at each electrical and communication room and connect to pigtail extensions of the building grounding ring.

3.3 CONDUCTIVE PIPING

A. Bond all conductive piping systems (excluding fuel gas piping), interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.
B. Install braided type bonding jumpers with ground clamps on water meter piping to electrically bypass meter where the main is metallic on both sides of the meter. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.

3.4 CORROSION INHIBITORS

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

B. Where concrete penetration is necessary, non-metallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground wire and the opening shall be sealed with a suitable compound after installation of the ground wire.

3.5 SECONDARY EQUIPMENT AND CIRCUITS

A. Switchgear, Panelboards, Disconnects, and Switchboards; Connect metallic conduits, which terminate without mechanical connection to the housing, by grounding bushings and grounding conductor to the equipment ground bus.

B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits, sized in accordance with Article 250 of NFPA 70.

C. Boxes, Cabinets, Enclosures, and Panelboards:
   1. Bond the equipment grounding conductor to each pull box, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
   2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
   3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.

D. Motors and Starters: Provide lugs in motor terminal box and starter housing or motor control center compartment to terminate equipment grounding conductors.

E. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

F. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

G. Metallic Conduit: Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a bare grounding conductor to the equipment ground bus.

3.6 INSTALLATION

A. Install ground electrodes at locations indicated. Provide additional electrodes as required to achieve specified resistance to ground.

B. Install nominal 10" diameter x 18" long fiberglass "water valve" type enclosure, with cover, over each ground rod. The top of ground rods shall be 12" below finished grade. The rod and exothermic connection to the grounding electrode conductor shall be accessible from within enclosure. Fill the lower 3" of enclosure with crushed rocks. Top of enclosure shall be flush with finished grade.
C. Make rebar in concrete footing around the perimeter of the building electrically continuous such that the resulting installation consists of a concrete encased electrode per Article 250 of the NEC. Extend No. 1/0 THWN grounding electrode conductors from convenient points along the “ground ring” to the following points:

D. If it is determined that the rebar cannot be made electrically continuous, install a No 1/0 bare copper conductor in the footing around the perimeter of the building.

E. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing.

F. Bond together metal siding not attached to grounded structure; bond to ground.

G. Bond together reinforcing steel and metal accessories in pool and fountain structures.

3.7 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical grounding system, test resistance of each ground rod installation using the "Fall of Potential" method. Ground resistances shall be measured in normally dry conditions not less than 48 hours after rainfall and at low tide. Where tests show resistance to ground is over the specified value, take appropriate action to reduce resistance by driving additional sections of ground rods and then retest to demonstrate compliance. Tests shall be conducted in the presence of the Project Electrical Engineer. Provide forms to record the data as the tests are conducted. Forms shall be signed by the person conducting the test and included with project closeout documents.

END OF SECTION 260526
SECTION 260529 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the requirements for the following:
   1. Conduit and equipment supports.
   2. Anchors and fasteners.

1.2 SUBMITTALS

A. Refer to section 260510.

1.3 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 REFERENCE STANDARDS


PART 2 - PRODUCTS.

2.1 MATERIALS

A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
B. Supports: Fabricated of structural steel or formed steel members; galvanized.
C. Anchors and Fasteners:
   1. Do not use powder-actuated anchors.
   2. Concrete Structural Elements: Use precast inserts, expansion anchors, or preset inserts.
   3. Steel Structural Elements: Use beam clamps, steel spring clips, steel ramset fasteners, or welded fasteners.
   4. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
   5. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.
   7. Sheet Metal: Use sheet metal screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.
   1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
B. Cutting or Holes:
   1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the Architect prior to drilling through structural sections.
   2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Architect as required by limited working space.

C. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

D. Install surface-mounted cabinets with minimum of four anchors.

E. In wet and damp locations use steel channel supports to stand cabinets and disconnects 1 inch off wall.

F. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

G. Use stamped steel bridges to fasten flush mounting outlet box between studs.

H. Use adjustable steel channel fasteners for hung ceiling outlet box.

I. Do not fasten boxes to ceiling support wires.

J. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

K. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

L. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.

M. Do not support conduit with wire, wire ties, or perforated pipe straps. Remove wire used for temporary supports.

N. Do not attach conduit to ceiling support wires.

END OF SECTION 260529
SECTION 260533 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS
   A. Refer to section 260510

1.2 QUALITY ASSURANCE
   A. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

1.3 REFERENCE STANDARDS
   A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); current edition
   B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); current edition
   C. ANSI C80.5 - American National Standard for Electrical Rigid Aluminum Conduit (ERAC); current edition
   E. NECA 101 - Standard for Installing Steel Conduit (Rigid, IMC, EMT); National Electrical Contractors Association; current edition
   F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; current edition

1.4 DELIVERY, STORAGE, AND HANDLING
   A. Accept conduit on site. Inspect for damage
   B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

PART 2 - PRODUCTS

2.1 CONDUIT REQUIREMENTS
   A. Conduit Size: Comply with NFPA 70.
      1. Minimum Size: 3/4 inch
   B. Wet and Damp Locations:
      1. Exterior above ground and in pipe basements: RMC, IMC, or LTFMC (LTFMC shall be only used with restrictions, see conduit installation)
      2. Exterior below ground: RNC schedule 40
      3. Interior: RMC, IMC, or LTFMC (LTFMC shall be only used with restrictions, see conduit installation)
      4. Interior below grade: RNC schedule 40
      5. Where RNC Schedule 40 is installed below grade or under floor slabs, the elbows required to turn the raceway up through the slab shall be RMC.
C. Dry Locations:
   1. Concealed: Use EMT or FMC (FMC shall be only used with restrictions, see conduit installation)
   2. Exposed: Use EMT or FMC (FMC shall be only used with restrictions, see conduit installation)
   3. Interior below grade: RNC schedule 40

D. Area subject to physical damage: RMC, IMC, or LTFMC (LTFMC shall be only used with restrictions, see conduit installation)
   1. “Areas subject to physical damage” shall be defined as the most stringent of the following:
      a. Exposed conduit below eight feet above finished floor.
      b. As interpreted by the authority having jurisdiction (AHJ).

2.2 METAL CONDUIT

A. Rigid Steel Galvanized Conduit (RMC): ANSI C80.1.


C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.
   1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
   2. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
   3. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
   4. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
   5. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
   6. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.

2.3 FLEXIBLE METAL CONDUIT

A. FLEXIBLE METAL CONDUIT (FMC) Description: Interlocked steel construction. Flexible metal conduit shall conform to UL 1.

B. Fittings: NEMA FB 1.
   1. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
   2. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
   3. Clamp type, with insulated throat.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LTFMC) Description: Interlocked steel construction with PVC jacket. Liquid-tight flexible metal conduit: Shall Conform to UL 360.

   1. Only steel or malleable iron materials are acceptable.
   2. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
   3. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
   4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.
2.5 ELECTRICAL METALLIC TUBING

A. ELECTRICAL METALLIC TUBING (EMT) Description: ANSI C80.3

B. Fittings and Conduit Bodies: NEMA FB 1; steel compression type.
   1. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
   2. Only steel or malleable iron materials are acceptable.
   3. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
   4. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 2 inches and smaller.
   5. Indent type connectors or couplings are prohibited.

C. All EMT conduit shall be Anodized with the following color coating:
   1. Life Safety Branch: Yellow
   2. (HVAC) Equipment Power Branch: Green
   3. Normal Power and HVAC controls: Silver
   4. Fire Alarm System: Red
   5. Communication Systems: Black

2.6 NONMETALLIC CONDUIT

A. RIGID NONMETALLIC CONDUIT (RNC): Direct burial plastic conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).

B. RNC: NEMA TC 2, schedule 40 PVC

C. Fittings shall meet the requirements of UL 514C and NEMA TC3

D. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.7 EXPANSION AND DEFLECTION COUPLINGS

A. Conform to UL 467 and UL 514B.

B. Accommodate, 0.75 inch deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.

C. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC code tables for ground conductors.

D. Jacket: Flexible, corrosion resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.

2.8 CORROSION PROTECTION

A. Corrosion protection for conduits passing through concrete slabs shall be by one of the following means: field-wrapped with 3M Scotchrap No. 50, 2-inch wide (minimum), with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify routing and termination locations of conduit prior to rough-in.
B. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to provide a complete wiring system.

3.2 CONDUIT INSTALLATION

A. All fire alarm cable shall be installed in metallic conduit. Coordinate with fire alarm system manufacturer for cable routing and quantities.

B. Install conduit securely, in a neat and workmanlike manner, as specified in NECA 101.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight.

D. Arrange supports to prevent misalignment during wiring installation.

E. Arrange conduit to maintain headroom and present neat appearance.

F. Route exposed conduit parallel and perpendicular to walls.

G. Route conduit installed above accessible ceilings parallel and perpendicular to walls.

H. Route conduit in and under slab from point-to-point.

I. Maintain adequate clearance between conduit and piping.

J. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.

K. Cut conduit square using saw or pipe cutter; de-burr cut ends.

L. Bring conduit to shoulder of fittings; fasten securely.

M. For power conduits install no more than equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one shot bender to fabricate bends in metal conduit larger than 2 inch size.

N. For communication conduits install no more than the equivalent of two 90 degree bends between pull points. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one shot bender to fabricate bends in metal conduit larger than 2 inch size.

O. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

P. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control, and expansion joints.

Q. Seal the inside of all conduits where conduit passes below floor or outside of the building.

R. Provide suitable pull string in each empty conduit except sleeves and nipples.

S. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

T. Do not install FMC or LTFMC in lengths over 6’.

U. Use LTFMC or FMC only to connect to equipment subject to vibration or to suspended light fixtures.
V. Wherever possible, install horizontal raceway runs above water and drain piping. Give the right-of-way in confined spaces to piping that must slope for drainage and to larger HVAC ductwork and similar services that are less conformable than electrical services.

W. Complete the installation of electrical raceways before starting installation of cables within raceways.

X. Raceways shall not be installed exposed in finished spaces. Install concealed in walls, ceilings, below slab-on-grade or embedded in slabs above grade.

3.3 BOX INSTALLATION

A. Boxes for Concealed Conduits:
   1. Flush mounted.
   2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.

B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.

C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

D. Outlet boxes in the same wall mounted back-to-back are prohibited. A minimum 24 inch, center-to-center lateral spacing shall be maintained between boxes.

E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4 inches square by 2-1/8 inches deep, with device covers for the wall material and thickness involved.

3.4 IDENTIFICATION

A. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1"

B. On all junction box covers, identify the circuits with black marker.

END OF SECTION 260533
PART 1 - GENERAL

1.1 SUBMITTALS:
   A. Refer to section 260510.

PART 2 - PRODUCTS

2.1 DUCTBANKS
   A. Any grouping of conduits underground shall be considered a duct bank.
   B. Ducts shall be 4" diameter minimum, type EB40.
   C. Fittings for raceways shall be designed specifically for use with the type of raceway installed. All couplings or other connections shall be made tight and sealed to exclude water and concrete.
   D. Top, intermediate and bottom spacers of plastic, or other approved non-organic material, shall be provided to maintain a separation between raceways of not less than that shown on drawings. Spacers shall be of the type specifically intended for encased installations.

2.2 HANDHOLES
   A. Handholes shall be constructed of steel reinforced 3,000 pound, 28-day strength concrete, or reinforced polymer concrete manufactured in molded structural shapes, on undisturbed or thoroughly compacted earth and shall conform with details and dimensions indicated on the drawings. Neoprene or other suitable water-stops shall be provided at all concrete construction joints.
   B. Locations of handholes shall be as dimensioned. Where no locating dimensions are given, handholes shall be approximately where shown, with possible interferences with other utilities, etc.
   C. Frames and covers for handholes shall be heavy duty, top quality, close grained gray cast iron or reinforced polymer concrete, both being milled to provide a true fit. Covers shall be equipped with drop lift handles and with the word "ELECTRIC" cast thereon. Type and style of frames and covers shall be as indicated on the drawings.
   D. Hardware shall be of gray cast iron or hot-dip galvanized steel.
   E. Water, mud, and trash shall be periodically pumped or otherwise removed from handholes by the Contractor until final acceptance of the work.
   F. Metal Frames and Covers: Shall be made of cast iron. Cast iron frames and covers shall meet Fed Spec. RR-F-621. Covers shall be rated AASHTO H20. The words "electric" shall be cast in the top face of the covers.

2.3 WARNING TAPE
   A. Provide a plastic warning tape in the backfill above all underground cables, conduits and duct banks. The tape shall be 3 inches wide, shall be bright, fade-resistant yellow in color, and shall include an imprinted legend, "WARNING - BURIED HIGH VOLTAGE LINE", "WARNING - BURIED FIBER OPTIC LINE" or "WARNING - BURIED TELEPHONE LINE", as applicable, repeated continuously throughout the entire length. Tape shall be buried 12 inches below top of trench.
PART 3 - EXECUTION

3.1 GENERAL

A. Layout of duct banks is the responsibility of the Contractor. Coordinate layout with existing site conditions, the elevation of manhole openings and work by other trades. Duct lines shall be sloped to drain towards manholes and pull boxes, with a pitch of not less than 3 inches in 100 feet. For lines run between adjacent manholes or pull boxes, high point may occur in the middle of run.

B. Excavation, Trenching and Backfilling: Provide as required to install duct banks in the manner indicated on the drawings and in accordance with the applicable sections of Division 31 through 33 of the specifications.

C. Provide barricades with warning lights, around all trenches. Barricades shall be orange mesh type supported by rods driven into the earth. Barricades shall remain in place at all times, not just at night. Maintain the integrity and appearance of the barricades until the trenches have been backfilled and compacted.

D. Clearance from Other Utilities: Do not install lines installed under this contract in the same trenches with other utilities. Maintain horizontal and vertical separation as required by ANSI C2.

3.2 INSTALLATION

A. During construction, partially completed duct lines shall be protected from the entrance of debris such as mud, sand and dirt, by means of suitable conduit plugs. As each section of a duct line is completed from manhole to manhole, a testing mandrel not less than 12 inches long with a diameter 1/4-inch less than the size of the conduit, shall be drawn through each conduit, after which a brush having the diameter of the conduit, and having stiff bristles, shall be drawn through until the conduit is clear of all particles of earth, sand, and/or gravel; conduit plugs shall then be immediately installed.

B. Install spacers every 5' along the duct run and at the midpoint and points of tangency of all bends. Anchor spacers to trench to ensure that the duct banks are held securely in place during concrete pours.

C. Ducts shall be encased in concrete as shown on the drawings. Care shall be taken that no voids are left between ducts.

D. Ducts crossing roadways and parking lots shall be reinforced as indicated on the drawings. Cutting and patching shall conform to the details shown on the Civil drawings. Engage the services of the paving and grading contractor to perform all cutting and patching.

E. Install warning tape 12" below grade along the entire length of, and centered on duct banks.

F. Bends: Except at conduit risers, changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 25 feet. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 48".

G. Connections to Handholes: Connections shall be constructed to have a flared section adjacent to the manhole to provide shear strength. Underground structures shall be constructed to provide for keying the concrete envelope of the duct line into the wall of the structure. Vibrators shall be used when this portion of the envelope is poured to assure a seal between the envelope and the wall of the structure. Conduits shall terminate in end-bells where duct lines enter manholes.

3.3 RECONDITIONING OF SURFACES
A. Ground covering and vegetation disturbed during installation, shall be restored to original elevation and condition.

B. Sod or topsoil shall be preserved carefully and replaced after the backfilling is completed. Sod that is damaged shall be replaced by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, the restored surface shall be re-seeded with the same quantity and formula of seed as that use in the original seeding.

3.4 CABLE PULLING

A. Pull cables down grade with the feed-in point at the handhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through the handhole opening and into the conduit. Cable slack shall be accumulated at each handhole where space permits. Minimum allowable bending radii shall be maintained.

B. Lubricants: For assisting in the pulling of cables shall be those specifically recommended by the cable manufacturer. The lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings.

C. Cable Pulling Tensions: Shall not exceed the maximum pulling tension recommended by the cable manufacturer.

D. Grounding Conductor: Secondary cable runs, 600 volts and less, in non-metallic conduit shall, although not indicated, include an insulated copper equipment grounding conductor sized as required by the rating of the overcurrent device supplying the phase conductors.

END OF SECTION 260543
SECTION 260548 – VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 260510.

1.2 QUALITY ASSURANCE

A. Submittals must be signed and sealed shop drawings from a professional engineer licensed in the state that the project is located in. Shop drawings to include project specific details, sketches, product data cut sheets.

B. The contractor shall provide pre-engineered seismic restraint systems to meet total design lateral force requirements for support and restraint of piping, conduit, cable trays and other similar systems and equipment where required by the applicable building code.

C. System Supports/Restrains Manufactures shall be firms regularly engaged in the manufacture of products of the types specified in this section, whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 - PRODUCT

2.1 SEISMIC BRACING

A. General:
   1. Seismic restraint designer shall coordinate all attachments with the structural engineer of record.
   2. Design analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
   3. Analysis shall detail anchoring methods, bolt diameter, and embedment depth.
   4. All seismic restraint devices shall be designed to accept without failure the forces calculated per the details and notes on the construction documents

B. Friction from gravity loads shall not be considered resistance to seismic forces.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All seismic restraint systems shall be installed in strict accordance with the manufacturer’s seismic restraint guidelines manual and all certified submittal data

B. Installation of seismic restraints shall not cause any change in position of equipment or piping, resulting in stresses or misalignment.

C. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.

D. Do not install any equipment, piping, duct, or conduit that makes rigid connections with the building.

E. Prior to installation, bring to the architect’s/engineer’s attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.
F. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast in place inserts, or wedge-type concrete anchors. Consult structural engineer of record.

G. Overstressing of the building structure shall not occur from overhead support of equipment. Bracing attached to structural members may present additional stresses. The contractor shall submit loads to the structural engineer of record for approval in this event.

H. Brace support rods when necessary to accept compressive loads. Welding of compressive braces to the vertical support rods is not acceptable.

I. Provide reinforced clevis bolts where required.

J. Seismic restraints shall be mechanically attached to the system. Looping restraints around the system is not acceptable.

K. Do not brace a system to two independent structures such as a ceiling and wall.

L. Provide appropriately sized openings in walls, floors, and ceilings for anticipated seismic movement.

M. Provide seismic controls as required for all existing electrical items exposed during renovations.

3.2 FIELD QUALITY CONTROL

A. Inspect all seismic supports after installation and submit a report from a professional engineer licensed in the state that the project is located in.

END OF SECTION 260548
SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 260510.

PART 2 - PRODUCTS

2.1 NAMEPLATES AND LABELS

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background unless noted otherwise.

B. Locations:
   1. Each electrical distribution and control equipment enclosure.

C. Letter Size:
   1. Use 1/4 inch letters for identifying grouped equipment and loads.

D. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background. Use only for identification of individual wall switches, receptacles, and control device stations. Labels shall identify the panel and circuit number (Ex: PANEL: CIRCUIT).

E. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.2 INSTALLATION

A. Install nameplates and labels parallel to equipment lines.

B. Secure nameplates to equipment front using corrosion resistant screws.

C. Secure nameplates to inside surface of door on panelboard that is recessed in finished locations.

D. Provide name plates on all disconnects, panels, switchboards, switchgear, and motor starters.

E. Provide labels on all receptacles, light switches, and wall mounted occupancy sensors.

END OF SECTION 260553
SECTION 260574 - SHORT CIRCUIT, OVERCURRENT PROTECTION, ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1. Coordination of series-rated devices is permitted where indicated on Drawings.

1.3 SUBMITTALS

A. Refer to section 260510.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Registered Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

1.5 REFERENCES

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

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

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents

C. The National Fire Protection Association (NFPA)
   1. NFPA 70 - National Electrical Code, latest edition
      a. NFPA 70E – Standard for Electrical Safety in the Workplace

PART 2 - PRODUCTS

2.1 STUDIES

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

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

2.2 DATA COLLECTION

   A. Contractor shall furnish all field data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

   B. Source combination may include present and future utility supplies, motors, and generators.

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

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

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

   A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.

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

   C. Provide the following:
      1. Calculation methods and assumptions
      2. Selected base per unit quantities
      3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Typical calculations
6. Tabulations of calculated quantities
7. Results, conclusions, and recommendations

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
   1. Electric utility’s supply termination point
   2. Incoming switchgear
   3. Unit substation primary and secondary terminals
   4. Low voltage switchgear
   5. Motor control centers
   6. Standby generators and automatic transfer switches
   7. Branch circuit panelboards
   8. Other significant locations throughout the system

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

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

2.4 PROTECTIVE DEVICE COORDINATION STUDY

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

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

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

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

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

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

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

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

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

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

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

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

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

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

2.6 REPORT SECTIONS

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

B. Short-Circuit Data:
   1. Source fault impedance and generator contributions
   2. X to R ratios
   3. Asymmetry factors
4. Motor contributions
5. Short circuit Kva
6. Symmetrical and asymmetrical fault currents

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

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

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

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

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

C. Notify Architect / Engineer in writing of any required major equipment modifications.

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

3.2 ARC FLASH WARNING LABELS

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

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

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

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

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

3.3 ARC FLASH TRAINING

A. The equipment vendor shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard For Electrical Safety Requirements For Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET).

END OF SECTION 260574
SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUBMITTALS

A. Refer to section 260510.

1.2 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

D. Dry type transformers shall be in accordance with NEMA standards

1.3 REFERENCES

A. NEMA ST 1 - Specialty Transformers (Except General Purpose Type); National Electrical Manufacturers Association; current edition

B. NEMA ST 20 - Dry-Type Transformers for General Applications; National Electrical Manufacturers Association; current edition


D. NFPA 70 - National Electrical Code; National Fire Protection Association; current edition

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry conditioned space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers, contingent upon compliance with the contract documents, are as listed below. Bidders shall carefully review the requirements listed in the technical specifications and only submit products that are equal or better. Equal products by other manufacturers are acceptable providing substitutions are submitted in accordance with requirements listed in the “Instructions to Bidders” and “Supplemental Instructions to Bidders” (SCOSE AIA A701) and approved by the A/E. Bidders shall carefully review the front end documents (SCOSE AIA A701) and submit all information required to allow the A/E the ability to make a fully informed decision.
1. Eaton Electrical/Cutler-Hammer
2. GE Industrial
3. Square D
4. Siemens

2.2 TWO-WINDING TRANSFORMERS

A. Description: NEMA ST 20, factory-assembled, air-cooled dry type transformers.
B. Primary Voltage: As indicated on plans.
C. Secondary Voltage: As indicated on plans.
D. Insulation system and average winding temperature rise: Class 220 with 150 degrees C rise.
E. Case Temperature: Do not exceed 35 degrees C rise above ambient at warmest point at full load.
F. Winding Taps: minimum of two 5 percent below rated voltage, and two 5 percent above rated voltage.
G. Sound Levels: comply with NEMA ST 20; Maximum sound levels shall not exceed the following:

<table>
<thead>
<tr>
<th>Transformer Rating</th>
<th>Sound Level Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 9 KVA</td>
<td>40 dB</td>
</tr>
<tr>
<td>10 - 50 KVA</td>
<td>45 dB</td>
</tr>
<tr>
<td>51 - 150 KVA</td>
<td>50 dB</td>
</tr>
<tr>
<td>151 - 300 KVA</td>
<td>55 dB</td>
</tr>
<tr>
<td>301 - 500 KVA</td>
<td>60 dB</td>
</tr>
</tbody>
</table>

H. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
I. Mounting: suitable for wall; floor; trapeze mounting.
J. Coil Conductors: Continuous copper windings with terminations brazed or welded.
   1. Indoor - Type 1; Type 3R; Ventilated
   2. Wet locations (outdoor or indoor) - Type NEMA 4R; Non-ventilated;
   3. Provide lifting eyes or brackets.
L. Isolate core and coil from enclosure using vibration-absorbing mounts.
M. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.
N. Electrostatic Shield: Copper, between primary and secondary windings.
O. Transformer impedance value shall be manufacturer's standard for size transformer provided unless noted otherwise.
P. Transformers shall meet the minimum energy efficiency values per DOE 2016 Efficiency.

2.3 SOURCE QUALITY CONTROL
A. Production test each unit according to NEMA ST 20.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set transformers plumb and level.

B. Use flexible conduit, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer.

D. Mount floor-mounted transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure. Floor mounted transformers shall be installed on a 4" high concrete pad with 3" minimum overlap on all sides. Anchor transformer to pad.

E. Mount trapeze-mounted transformers as indicated.

F. Installation of transformers shall be such that air circulation around the units is not restricted. Hold 6" off walls.

G. For suspended transformers, coordinate exact placement with sprinkler system installer.

3.2 FIELD QUALITY CONTROL

A. Perform inspections and tests listed in NETA STD ATS, Section 7.2. In addition to the basic requirements of Section 7.2, include the following:
   1. Measure the resistance of each winding at each tap connection.
   2. Overpotential test on all high- and low-voltage windings-to-ground.
   3. Infrared testing on transformer and terminations.

3.3 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION 262200
SECTION 262400 – SWITCHBOARDS AND PANELBOARDS

PART 1 - GENERAL

1.1 SUBMITTALS

A. See section 260510.

1.2 QUALITY ASSURANCE

A. Where switchboards or panelboards are used as service entrance equipment, they shall comply with all NEC and UL requirements for service entrance and a UL service entrance label shall be provided.

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.3 REFERENCE STANDARDS


B. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association; current edition.

C. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; current edition.


PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Eaton Electrical/Cutler-Hammer

B. GE Industrial

C. Square D

D. Siemens

2.2 SWITCHBOARDS

A. Provide factory-assembled, front accessible dead-front, metal-enclosed, free-standing switchboards.

B. Unless shown otherwise, switchboard shall consist of separate sections for termination/metering, main breaker and distribution.

C. The bus shall be copper with 98 percent conductivity.

D. Vertical bus shall be the full height of the switchboard.

E. Horizontal bus shall be fully sized for entire length of switchboard, and shall have provisions for future extension (bus stabs). The complete assembly shall be listed for 100% rating.
F. Provide full sized copper with 98 percent conductivity neutral bus.

G. Provide copper with 98 percent conductivity ground bus rated not less than 25% of main bus or as required by the NEC, whichever is greater.

2.3 SWITCHBOARD METERING

A. Provide Square D Power Logic Circuit Monitor CM-4250, complete with current transformers and interconnecting wiring, all rated for 1% accuracy. Unit shall be factory installed and tested. Flush mount meter in termination compartment. Equivalent metering by Westinghouse, G.E. or Siemens are acceptable.

B. Power Circuit Monitoring and Control System: The Power Circuit Monitor shall be a multi-functional, digital, data acquisition and control device. The Power Circuit Monitor shall be metered over 50 values and extensive Min/Max data can be viewed on the LED display. Each Circuit Monitor shall offer true RMS metering and communications standard. Provide 0.2% accuracy true RMS metering and other powerful features such as automatic relay control, waveform capture, on-board event and data logging, and programmable logic for special applications like custom data logging and control function. On-board memory can be expanded to add 512 K or 1024K. Provide input/output modules, status inputs, a pulse output, relay outputs and analog inputs and outputs.

1. Power Circuit Monitor shall be
   a. Certified ANSI C12.16 revenue accuracy
   b. True RMS Metering through the 31st harmonic
   c. High accuracy: 0.2% on current and voltage
   d. Power quality readings displayed: THD and K-Factor
   e. Harmonic Analysis Data through 63rd harmonic
   f. Automatic Alarm/Relay control
   g. On-board event and data logging
   h. Waveform capture
   i. UL listed, CSA Approved, CE Marketing, NOM Approved
   j. MV-90 compatible

C. Recording Demand Meter: Usable as totalizing relay or as indicating and recording maximum-demand meter with 15-minute interval. Meter shall count and control a succession of pulses entering two channels. House in drawout, back-connected case arranged for semiflush mounting.

2.4 PANELBOARDS

A. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

B. Panelboard Bus: Copper (98% conductivity).

C. Provide copper ground bus in each panelboard

D. Enclosure: Interior - NEMA 1, Kitchen/Exterior locations – gasketed, stainless NEMA 4X

E. Cabinet Front: Flush cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel. Paint all hallway panels to match wall finish.

F. All panelboards shall be hinged “door in door” type with:
   1. Interior hinged door with hand operated latch or latches as required to provide access to circuit breaker operating handles only, not to energized ports.
2. Outer hinged door shall be securely mounted to the panelboard box with factory bolts, screws, clips or other fasteners requiring a tool for entry, hand operated latches are not acceptable.
3. Push inner and outer doors shall open left to right.

G. All panelboard shall have bolt-on style breakers.
H. Provisions for future breakers shall be fully bussed complete with all necessary mounting hardware.

2.5 CIRCUIT BREAKERS

A. For circuit breakers 1200 amps and over (or capable of being adjusted to 1200 amps and over) – Provide a means of arc energy reduction per NEC 2014 240.87.

B. For Circuit breakers 1000 Amps and over – Provide low voltage AC power circuit breaker, with fixed mounting, stored energy and solid state trip devices.
   1. Provide individual adjustable solid-state elements as an integral part of the solid-state trip devices for complete system selective coordination. All breakers shall have LSI settings. 277/480V breakers shall have LSIG settings.
   2. Position indicator: Provide an indicator visible from the front of the unit to indicate whether the breaker is open or closed.
   3. Trip button: Provide a mechanical trip button accessible from the front of the door to trip the breaker.
   4. Padlocking: Include provisions for padlocking the breaker in the open position.
   5. Operation: Unless otherwise shown on the drawings, breakers 1600 ampere frame size and less may be manually operated. Breakers larger than 1600 amperes frame size shall be electrically operated.
   6. Trip devices shall have the following features:
      a. Trip device in each pole.
      b. Metering, voltage, current memory and LCD display
      c. Mechanically and electrically trip free.
      d. Long time element with adjustable pick-up and selective maximum, intermediate, and minimum time delay bands.
      e. Short time element with adjustable pick-up and selective maximum, intermediate, and minimum time delay bands.
      f. Ground fault element with adjustable pick-up and selective maximum, intermediate and minimum time delay bands.
      g. Maintenance setting option to reduce Arc Flash hazards.

C. For circuit breakers over 400 amps provide -Adjustable Trip molded case, solid state adjustable trip type circuit breakers.
   2. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   3. Shunt Trip: 120V trip coil energized from separate circuit, set to trip a 75 percent of rated voltage.
   4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
   5. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
   6. Trip units shall have field adjustable tripping characteristics as follows:
      a. Ampere setting (continuous).
      b. Long time band.
      c. Short time trip point.
d. Short time delay.
e. Instantaneous trip point.

D. For all circuit breakers 400 amps and smaller provide - Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers.
   1. Type SWD for lighting circuits.
   2. Type HACR for air conditioning equipment circuits.
   3. Class A ground fault interrupter circuit breakers where scheduled.
   4. Do not use tandem circuit breakers.
   5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration for all residential applications.
   6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

E. Circuit breakers serving elevators, shall have adjustable long-time setting and shall be provided with a shunt trip coil rated for 120V operation. Breaker shall also have a set of Form C contacts. Connect shunt trip coil to operate as indicated on the drawings.

F. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

2.6 CONTROL WIRING:

A. Control wiring shall be 600 volt class B stranded SIS. Install all control wiring complete at the factory adequately bundled and protected. Wiring across hinges and between shipping units shall be Class C stranded. Size in accordance with NEC. Provide control circuit fuses. Provide integral power supply in switchgear for control power.

2.7 SHORT CIRCUIT CURRENT RATING:

A. Devices which achieve the level of fault protection indicated by means of "series" or "integrated" rating shall not be acceptable unless specifically indicated on the drawings. All panelboards shall be fully rated.

B. Minimum SSCR
   1. 208 Volt Panelboards: Minimum 10,000 amperes rms symmetrical unless noted otherwise on plans.
   2. 480 Volt Panelboards: Minimum 22,000 amperes rms symmetrical unless noted otherwise on plans.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1 and NECA 1.

B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.

C. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

D. Provide filler plates for unused spaces in panelboards.

E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect
circuiting changes required to balance phase loads.

F. Provide engraved plastic nameplates on all switchboard and panelboards.

G. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.
   1. Minimum spare conduits: 6 empty 1 inch conduits.

H. Ground and bond panelboard and switchboard enclosure according to Section 26 05 26.

I. Do not splice conductors in panelboard or switchboard enclosure.

J. Install switchboard on 4" high concrete pad with 3" minimum overlap on all sides. Bolt switchboard to pad in all four corners, minimum.

K. Each section of two section panels shall contain only those conductors which originate in that section. Do not use panel as a wireway.

L. Piggy-back or tandem type breakers shall not be used.

M. Multi-pole breakers shall be common trip, with a single handle.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA STD ATS, except Section 4.

B. Perform inspections and tests listed in NETA STD ATS, Section 7.5 for switches, Section 7.6 for circuit breakers.

3.3 ADJUSTING

A. Adjust the breaker trip set points per the values provided by the engineer, per an Overcurrent protective device study provided by the contractor.

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

C. Clean all debris from panel interiors.

3.4 LABELING

A. Provide nameplates on all electrical panels that new circuits are modified or installed. Indicate the following information:
   1. Panel name
   2. Panel fed from
   3. Normal (Black with white letters), Emergency Equipment (Green with black letters), or Emergency Life safety (Yellow with black letters)
   4. Voltage, phase, wire, short circuit current rating
   5. Date installed

B. Provide a typed legend for all modified or new electrical panels. Update the panel board schedules after load balancing.

C. Identify load served and location by room names assigned by user, not by room numbers on floor plans. Note spares and spaces as such.
D. For switchboards Provide laminated plastic nameplate for main and for each feeder circuit. Nameplates shall be secured to switchboard with two screws.

E. Provide ARC flash identification per NFPA 70E.

3.5 CLEARANCE AND WORKSPACE

A. Maintain workspace and clearances as required by the NEC for the voltage encountered. No pipes or ducts shall pass above the outline of the panelboard. It shall be the responsibility of this Contractor to make sure that other trades do not encroach on this space.

END OF SECTION 262400
SECTION 262726 – WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the requirements for the following:
   1. Receptacles.
   2. Device plates.
   3. Wall switches.
   4. Occupancy Sensors

1.2 SUBMITTALS

A. Refer to section 260510.

1.3 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 OCCUPANCY SENSOR DRAWING

A. Drawing Format: Drawings shall be prepared at a scale of no less than 1/16”=1’-0”. Drawing shall be titled to define Project Name, Drawing subject and date prepared. Drawings are to be prepared in AutoCAD 2004 or compatible software.

1.5 REFERENCE STANDARDS


B. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; current edition.

C. NEMA WD 6 - Wiring Device -- Dimensional Requirements; National Electrical Manufacturers Association; current edition.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Acceptable manufacturers, contingent upon compliance with the contract documents, are as listed below. Bidders shall carefully review the requirements listed in the technical specifications and only submit products that are equal or better. Equal products by other manufacturers are acceptable providing substitutions are submitted in accordance with requirements listed in the “Instructions to Bidders” and “Supplemental Instructions to Bidders” (SCOSE AIA A701) and approved by the A/E. Bidders shall carefully review the front end documents (SCOSE AIA A701) and submit all information required to allow the A/E the ability to make a fully informed decision.

1. Cooper Wiring Devices
2. GE Industrial
3. Leviton Manufacturing, Inc
4. Hubbell, Inc
5. Lutron Electronics Inc
6. Wattstopper Inc
7. Schneider Electric
8. Legrand – Pass & Seymour
9. C.W. Cole & Company

2.2 RECEPTACLES

A. Receptacles: Specification Grade Receptacles, complying with NEMA WD 6 and WD 1.
   1. Device Body: color by architect, plastic, or Red for emergency power devices.
   2. Configuration: NEMA WD 6, type as specified and indicated.
   3. Type 5-20.

B. GFCI Receptacles: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements. Feed through GFCI devices shall not be used. GFCI devices shall contain self-testing feature with power lockout if self-test fails.

C. Special Purpose Receptacles: Provide heavy-duty type as indicated on the drawings.

D. Wet Location: A receptacle installed in a wet location shall be GFCI listed weather-resistant type.

2.3 WALL PLATES

A. Cover Plates: Provide one piece wall plates for wiring devices, with ganging and cutouts as required. Provide blank wall plates for all un-used outlet boxes. Provide with metal screws for securing plates to devices, screw heads colored to match finish of plate. All plates shall be standard size, smooth stainless steel.

B. Weatherproof Cover Plates: All devices installed outdoors and indoor devices specifically indicated, shall be provided with weatherproof covers. Covers shall be of the type that maintains weatherproof integrity when in-use and not in-use. Covers shall be listed and identified as “extra duty” type.

2.4 WALL SWITCHES

A. Wall Switches: Heavy Duty, AC only general-use snap switch, complying with NEMA WD 6 and WD 1.
   1. Body and Handle: color by architect, plastic with toggle handle, or red for emergency power devices.
   2. Locator Light: Lighted handle type switch; red color handle.
   3. Ratings: Match branch circuit and load characteristics.

B. Switch Types: Single pole, double pole, 3-way, and 4-way.

2.5 OCCUPANCY SENSORS

A. Wall switch sensors: Passive Infrared type.
   1. Capable of detection of occupancy at desktop level up to 300 sqft, and gross motion up to 1000 sqft with 180 degree coverage capability.
   2. Rating: Sensor rating shall be at least 125% of the connected load.
   4. Sensor shall have no leakage current to load, and voltage drop protection.
   5. Sensor shall provide high immunity to false triggering from RFI and EMI.
   6. Sensor shall be capable of operating normally with electronic ballasts, PL lamp systems and
7. Sensor shall utilize automatically adjustable time delay and sensitivity settings.
8. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
9. A bypass manual override shall be provided on each sensor.
10. An integral photo cell with adjustable light level shall be provided
11. All sensors shall have UL rated, 94V-0 plastic enclosures.

B. Ceiling Sensors: Dual Technology type.
   1. Rating: Sensor rating shall be at least 125% of the connected load.
   2. Sensor shall be ceiling mounted in such a way as to minimize coverage in unwanted areas.
   3. Sensor shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered.
   4. Passive Infrared Sensor shall provide high immunity to false triggering from RFI and EMI.
   5. Ultrasonic Sensor shall adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout the controlled space.
   6. Sensor shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.
   7. Sensor shall utilize automatically adjustable time delay and sensitivity settings.
   8. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
   9. A bypass manual override shall be provided on each sensor.
   10. All sensors shall have UL rated, 94V-0 plastic enclosures.

C. Circuit Control Hardware – Where required.
   1. Control Unit: Self-contained unit consisting internally of isolated load switching relay(s) and transformer to provide low-voltage power.
   2. Control Unit shall provide power to a minimum of two sensors.
   3. Relay Contacts shall have ratings as required for connected load.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that outlet boxes are installed at proper height.
B. Verify that wall openings are neatly cut and will be completely covered by wall plates.
C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.
B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
B. Install devices plumb and level.
C. Do NOT utilize back wiring on any wiring device.

D. Install receptacles with grounding pole on top.

E. Do not install receptacles within 6” of the edge of sinks.

F. Connect wiring device ground terminal to outlet box with bonding jumper.

G. All receptacles installed as listed below shall be GFCI type.
   1. Receptacles installed outdoors.
   2. Receptacles installed within six feet of sinks.
   3. Receptacles designated for electric drinking fountains.
   4. Receptacles designated for vending machines.
   5. Any other receptacles specifically indicated on the drawings.

H. Install decorative plates in finished areas.

I. Connect wiring devices by wrapping conductor around screw terminal.

J. Provide engraved stainless steel wall plates that indicate the branch circuit to which the associated devices is connected. Use 1/8” high black letters.

K. Install switches with OFF position down.

3.4 FIELD QUALITY CONTROL

A. Perform all field inspection, testing, and adjusting specified in NETA STD ATS

B. Inspect each wiring device for defects.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

F. Operate each wall switch with circuit energized and verify proper operation.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. It shall be the contractor’s responsibility to locate and aim occupancy sensor in the correct location required for complete and proper volumetric coverage with the range of coverage(s) of controlled areas per the manufacturer’s recommendations. Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room.

C. Proper judgment must be exercised in executing the installation so as to ensure the best possible
installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. The contractor shall also provide, at the owner’s facility, the training necessary to familiarize the owner’s personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.

3.6  CLEANING

A. It is anticipated that painting and other finish work may occur after device installation. Device plates shall not be installed until these activities are completed. Protect device and conductors by installing molded plastic cover.

B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 262726
SECTION 262813 – FUSES

PART 1 - GENERAL

1.1 SUBMITTALS
   A. Refer to Section 260510.

1.2 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Cooper Bussman

2.2 FUSES – GENERAL
   A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
   B. Voltage: Rating suitable for circuit phase-to-phase voltage.
   C. Provide class R5 time delay fused for all motor applications.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION 262813
SECTION 262816 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUBMITTALS
   A. Refer to section 260510.

1.2 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
   C. Products: Furnish products listed and classified by Underwriters Laboratories Inc.; or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

1.3 REFERENCES
   A. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association; current edition.
   B. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; current edition.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Acceptable manufacturers:
      1. Eaton Electrical/Cutler-Hammer
      2. GE Industrial
      3. Square D
      4. Siemens

2.2 NON-FUSIBLE SWITCH
   A. Non-fusable Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
      1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
      2. Handle lockable in OFF position.

2.3 FUSIBLE SWITCH
   A. Fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
      1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
      2. Handle lockable in OFF position.
      3. Fuse clips: Designed to accommodate NEMA FU1, Class R or J fuse
B. Fusible switches serving elevators shall be provided with a set of Form C contacts.

2.4 MOLDED CASE CIRCUIT BREAKERS

A. Molded Case Circuit Breakers for circuit breakers smaller than 200 amps: UL listed for the following service conditions: Temperature: 40 degrees C. Provide HACR rated breakers where they serve HVAC equipment.

B. Field-Adjustable Trip Circuit Breakers: Provide circuit breakers with frame sizes 200 amperes and larger with mechanism for adjusting long time and short time current

C. Circuit breakers serving elevators shall have adjustable long-time setting. Breaker shall also have a set of Form C contacts.

2.5 ENCLOSURES

A. Enclosures: NEMA KS 1.
   1. Interior Dry Locations: Type 1.
   2. Exterior Locations: NEMA 4X stainless steel.

2.6 ACCESSORIES

A. Shunt Trip Device: 120; volts, AC; provide where indicated.
   24; volts, DC; provide where indicated.

B. Undervoltage Trip Device: 120; volts, AC; provide where indicated

C. Auxiliary NO and NC contact: 120; volts, AC; provide where indicated

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with Manufacturer’s instructions.

B. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

C. All switches associated with outdoor equipment shall be located as close to the equipment as possible (when equipment is in a service yard, switches shall also be in the service yard) and mounted such that the top of the switch is no more than 6'-6" above grade. All switches associated with equipment mounted above a lay-in ceiling shall also be located above the lay-in ceiling.

D. Coordinate safety and disconnect switch installation with surrounding equipment to provide unobstructed access to the switch (4 foot clearance) and to insure that the switch is within sight of the controller or driven equipment.

3.2 FIELD QUALITY CONTROL

A. Touch-up scratched or marred surfaces to match original finish.

B. Clean all debris from enclosure interiors.
C. Test all shunt trip and under voltage trip units.

3.3 LABELING

A. Provide nameplates on all switch enclosures wherein new circuits are modified or installed. Indicate the following information:
   1. Equipment Switch Serves.
   2. Branch Circuit.
   3. Normal (Black with white letters), Emergency Equipment (Green with black letters), or Emergency Life safety (Yellow with black letters)
   4. Voltage, phase, wire, short circuit current rating
   5. Date installed

3.4 CLEARANCE AND WORKSPACE

A. Maintain workspace and clearances as required by the NEC for the voltage encountered. No pipes or ducts shall pass above the outline of the switch enclosure. It shall be the responsibility of this Contractor to make sure that other trades do not encroach on this space.

END OF SECTION 262816
SECTION 262913 – ENCLOSED CONTROLLERS

PART 1 -  GENERAL

1.1  SUMMARY
   A. This section includes the requirements for the following:
      1. Magnetic motor controllers.
      2. Combination magnetic motor controllers and disconnects.

1.2  SUBMITTALS
   A. See section 260510.

1.3  QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Products: Listed and classified by Underwriters Laboratories Inc.; or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.4  REFERENCES
   B. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association; current edition
   C. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; National Electrical Manufacturers Association; current edition
   D. NEMA ICS 6 - Industrial Control and Systems: Enclosures; National Electrical Manufacturers Association; current edition
   E. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; current edition
   G. NFPA 70 - National Electrical Code; National Fire Protection Association;

PART 2 -  PRODUCTS

2.1  MANUFACTURERS
   A. Acceptable manufacturers, contingent upon compliance with the contract documents, are as listed below. Bidders shall carefully review the requirements listed in the technical specifications and only submit products that are equal or better. Equal products by other manufacturers are acceptable providing substitutions are submitted in accordance with requirements listed in the “Instructions to Bidders” and “Supplemental Instructions to Bidders” (SCOSE AIA A701) and approved by the A/E.
Bidders shall carefully review the front end documents (SCOSE AIA A701) and submit all information required to allow the A/E the ability to make a fully informed decision.

1. Eaton Electrical/Cutler-Hammer
2. GE Industrial
3. Square D
4. Siemens
5. Allen-Bradley Co.

2.2 MANUAL CONTROLLERS

A. Manual Motor Controllers: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light

B. Fractional Horsepower Manual Controllers: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light

C. Motor Starting Switches: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit.

D. Enclosures: NEMA ICS 6, Type 1

2.3 ACCESSORIES

A. Auxiliary Contacts: NEMA ICS 2, two normally open and two normally closed; for all automatic controllers.

B. Cover Mounted Pilot Devices: NEMA ICS 5

C. Indicating Lights: LED

D. Selector Switches: Rotary type.

E. Control Power Transformers: 120; volt secondary, 50 VA minimum, in each motor starter; or as scheduled. Provide fused primary, secondary, and bond unfused leg of secondary to enclosure.

2.4 DISCONNECTS

A. Combination Controllers: Combine motor controllers with disconnects in common enclosure. Obtain IEC Class 2 coordinated component protection.

B. Thermal Magnetic Circuit Breakers: Integral thermal and instantaneous magnetic trip in each pole; UL listed.

C. Motor Circuit Protector: Circuit breakers with integral instantaneous magnetic trip in each pole; UL listed.

D. Non-fusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle.

E. Fusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate Class R fuses.

PART 3 - EXECUTION
3.1 INSTALLATION

A. Install enclosed controllers where indicated, in accordance with manufacturer's instructions.

B. Install securely, in a neat and workmanlike manner, as specified in NECA 1.

C. Select and install overload heater elements in motor controllers to match installed motor characteristics.

D. Installation by the Contractor shall include firmly mounting motor controllers with overload re-set button or switch, or with operating handle of circuit breaker or switch for combination types, not over 6’6” above the floor or finished grade. All bolts, lugs and other connections shall be checked for tightness. All moving parts shall be checked for proper alignment and freedom of movement. All time-delay or sequencing relays shall be checked and properly adjusted or set.

E. Coordinate controller installation with surrounding equipment to provide unobstructed access (4 foot clearance) and to insure that the switch is within sight of the controller or driven equipment.

3.2 LABELING

A. Provide engraved plastic nameplates.

B. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

C. Starters shall have engraved plastic nameplates indicating the load served, load rating and the branch circuit number.
   1. Equipment Served.
   2. Branch Circuit.
   3. Voltage, phase, wire, short circuit current rating
   4. Date installed

3.3 FIELD QUALITY CONTROL

A. Controllers shall be checked for installation of properly sized overload heater units and all breaker instantaneous trip units shall be set as low as possible to allow motor to start.

B. All motors on motor operated equipment shall be checked for proper rotation.

END OF SECTION 262913
SECTION 263200 – PACKAGED GENERATOR ASSEMBLIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, complete installation, connection and testing of the engine generator system. This includes: air filtration, starting system, generator controls, instrumentation, lubrication, fuel system, cooling system and exhaust system.

B. The engine generator system shall be fully automatic and shall constitute a unified and coordinated system ready for operation.

C. The engine generator system shall include, but not be limited to the following:
   1. Diesel Engine.
   2. Lubrication Oil System.
   3. Cooling System.
   4. Intake and Exhaust Air Systems.
   5. Starting System.
   6. Generator.
   7. Controls, Supervision and Distribution.
   8. Outdoor Generator Enclosure.
   9. Spare Parts.

1.2 QUALITY ASSURANCE

A. Equipment shall be furnished by a dealer with service facilities and spare parts stock, as approved by Engineer, within 4 hours’ time of the job site by normal ground transportation. In addition, the dealer shall be able to demonstrate, in the judgment of the Engineer, adequate experience in the installation/service of standby power equipment of equivalent size and type specified herein.

B. The equipment supplied and installed shall meet the requirements of the NEC and all applicable local codes and regulations. All equipment shall be of new and current production by a manufacturer who has 10 years of experience building this type of equipment. Manufacturer shall be ISO9001 certified. There shall be one source responsibility for warranty; parts and service through a local representative with factory trained service personnel.

Automatic Transfer Switch
   Automatic transfer switch(es) specified in another section shall be supplied by the generator set manufacturer in order to establish and maintain a single source of system responsibility and coordination.

C. Two Year Standby (ISO 8528-1: ESP) Generator Set Warranty
   The manufacturer's standard warranty shall in no event be for a period of less than two (2) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Running hours shall be limited to 500 hours annually for the system warranty by both the manufacturer and servicing distributor. Submittals received without written warranties as specified will be rejected in their entirety.
Standby Generator Set Extended Warranty Coverage
Extended Warranty Coverage shall be provided for a period of 5 years, and shall include no deductible. Extended Warranty Coverage provides for 100 percent of usual and customary parts and labor costs for failures due to defects in materials and workmanship to the “as shipped consist” from the factory, excluding filters, fluids, vee belts, hoses, power take-offs, paint, batteries and clutches. Coverage provides for a rental power unit due to unscheduled failures causing unexpected downtime to the customer in excess of 48 hours from the time of diagnoses. All repairs will be performed by factory trained dealer service personnel, and allows for repairer travel for all repairs up to 8 hours per incident.

Parts and Service Qualifications
1. Service Facility
   The engine-generator supplier shall maintain 24-hour parts and service capability within 4 hours’ time of the job site by normal ground transportation. The distributor shall stock parts as needed to support the generator set package for this specific project. The supplier must carry sufficient inventory to cover no less than 80% parts service within 24hrs and 95% within 48 hours.

2. Service Personnel
   The dealer shall maintain qualified factory trained service personnel with experience on specified equipment within 4 hours’ time of job site by normal ground transportation.

D. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
7. Safety shutdown.
8. Provide 14 days’ advance notice of tests and opportunity for observation of tests by Owner’s representative.
9. Report factory test results within 10 days of completion of test.

1.3 SUBMITTALS
A. Refer to specification section 260510

1.4 STORAGE AND HANDLING
A. Equipment shall withstand the mechanical stresses caused by rough handling during shipment in addition to the electrical and mechanical stresses, which occur during operation of the system. Protect radiator core with wood sheet.
1.5 JOB CONDITIONS

A. Shall conform to the arrangements and details shown on the drawings. The dimensions, enclosures and arrangements of the engine-generator set shall permit the operating personnel to safely and conveniently operate and maintain the system in the space designated for installation.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. American National Standards Institute (ANSI):
   C37.50-00 Low-Voltage AC Power Circuit Breakers used In Enclosures-Test Procedures

C. American Society of Testing Materials (ASTM):
   B88-03 Specification for Seamless Copper Water Tube
   B88M-03 Specification for Seamless Copper water Tube (Metric)

D. Institute of Electrical and Electronic Engineers (IEEE):
   C37.13-95 Low Voltage AC Power Circuit Breakers Used In Enclosures
   C37.90.1-02 Surge Withstand Capability (SWC) Tests for Relays and Relay Systems
      Associated with Electric Power Apparatus

E. National Electrical Manufacturers Association (NEMA):
   AB 1-02 Molded Case Circuit Breakers and Molded Case Switches and Circuit Breaker Enclosures
   ICS 6-01 Industrial Control and Systems: Enclosures
   ICS 4-05 Terminal Blocks,
   MG 1-04 Motor and Generators
   MG 2-01 Safety Standard and Guide for Selection, Installation and use of Electric Motors and Generators
   PB 2-01 Dead-Front Distribution Switchboards
   SG 3-95 Low Voltage Power Circuit Breakers-Power Switching Equipment
   SG 5-95 Power Switchgear Assemblies
   250-03 Enclosures for Electrical Equipment (1000 Volts Maximum)

F. National Electrical Testing Association (NETA):
   ATS-95 Electrical Power Distribution Equipment and Systems

G. National Fire Protection Association (NFPA):
   30-03 Flammable and Combustible Liquids Code.
   37-02 Installations and Use of Stationary Combustion Engine and Gas Turbines
   70-05 National Electrical Code (NEC)

H. Underwriters Laboratories, Inc. (UL):
   50-03 Enclosures for Electrical Equipment
   142-02 Steel Aboveground Tanks for Flammable and Combustible liquids
   2085-95 Insulated Aboveground Tanks for Flammable and Combustible Liquids
2200-04 Stationery Engine Generator Assemblies
1236-02 Battery Charges for Charging Engine-Starter Batteries
467-04 Grounding and Bonding Equipment.
489-04 Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
508-05 Industrial Control Equipment
891-03 Dead-Front Switchboards

PART 2 - PRODUCTS

2.1 GENERATOR SET

A. The generator set shall be by one of the following:
   1. Caterpillar
   2. Cummins
   3. MTU

B. The engine generator system shall be in accordance with NFPA, UL, NEMA and ANSI.

C. Provide a factory-assembled, wired, (except for the field connections), complete, fully automatic diesel fuel generator system.

D. Published Rating:
   1. Shall be Standby 480/277 volts, 3-phase, 4-wire, 60 Hz and 0.80 power factor.
   2. Shall be capable of operating continuously for 24 consecutive hours within any 24-hour period of operation at 100 percent of its specified rating without damage.

E. Assemble, connect and wire the equipment at the factory so that only the external connections need to be made at the construction site.

F. Unit shall be factory painted with manufacturer's primer and standard finishes.

G. Coordinate the components of the system and their arrangements, electrically and mechanically.

H. Connections between components of the system shall conform to the recommendations of the manufacturer of the generator set.

I. Couplings, shafts, and other moving parts shall be enclosed and guarded. Guards shall be metal, ruggedly constructed, rigidly fastened and readily removable for convenient servicing of the equipment without disassembling any pipes and fittings.

J. Generator set and cooling system shall be furnished with extended life antifreeze solution to protect the system from freezing at all times.

K. Generator set shall have the following features:
   1. Factory-mounted on a common, rigid, welded, structural steel base.
   2. The maximum engine-generator set vibration in the horizontal, vertical, and axial directions shall be limited to 0.15mm with an overall velocity limit of 24 mm/sec RMS, for all speeds.
   3. The isolators shall be constrained with restraints capable of withstanding static forces in any direction equal to twice the weight of the supported equipment.
   4. Automatic start, accelerate to the specified RPM and deliver the specified KW/KVA output at 60 Hz within 10 seconds after a single pole contact closes in a remote device.
5. Recover rapidly from instantaneous changes between no load and the specified KW/KVA rating, and the reverse changes of load, without damage.
6. Shall be capable of operating satisfactorily as specified for not less than 10,000 hours between major overhauls.
7. Engine-generator set shall be statically and dynamically balanced at the factory in order to comply with the maximum vibration velocity specified.

2.2 DIESEL ENGINE

A. Coupled directly to a generator.
B. Minimum 4-cylinders.
C. Operating speed shall be 1800 RPM.
D. The engine shall be able to start in a 40 degrees F ambient temperature while using No. 2 diesel fuel oil without the use of starting aids such as glow plugs and ether injections.
E. Equipped with electric heaters for maintaining the engine’s coolant temperature in the range of 90-100 degrees F, or as recommended by the manufacturer.
   1. Install thermostatic controls, contactors, and circuit breaker protected circuits for the heaters.
   2. The heaters shall operate continuously except while the engine is operating or the water temperature is at the predetermined level.

2.3 GOVERNOR

A. Isochronous; electronic or hydraulic type.
B. Steady-state speed band at 60 Hz shall not exceed plus or minus 1/3 of one percent.
C. At 60 Hz, when load changes equal to 25 percent of the specified KW/KVA rating, frequency change shall not exceed two percent and it shall recover to 60 Hz within three seconds.
D. At 60 Hz, when load changes equal to 100 percent of the specified KW/KVA rating, frequency change shall not exceed eight percent and it shall recover to 60 Hz within five seconds.
E. While the engine is running, manual speed adjustments may be made.

2.4 LUBRICATION OIL SYSTEM

A. Pressurized type.
B. Positive-displacement pump driven by engine crankshaft.
C. Full-flow strainer and full-flow or by-pass filters.
D. Filters shall be cleanable or replaceable type and shall remove particles as small as 3 microns without removing the additives in the oil. For by-pass filters, flow shall be diverted without flow interruption.
E. Extend lube oil sump drain line passing out through the skid base and terminate it with a drain valve and plug.
F. Provide a 120-volt oil heater for exterior generator set.
2.5 FUEL SYSTEM

A. Day Tank:
   1. Each engine generator shall be provided with an integral (sub base) day tank with double-wall fuel containment.
   2. Each day tank shall have capacity to supply fuel to the engine for a 24-hour period without being refilled.
   3. Secure, pipe, and connect the tank adequately for maximum protection from fire hazards, including oil leaks.
   4. Incorporate a vent, drain cock, shutoff cocks, and gauge glass. Terminate the vent piping outdoors with mushroom vent cap.
   5. Day tank and engine supply line elevations shall be below the elevation of the injector return outlet on the engine.

B. Piping System: Black steel standard weight ASTM A-53 pipe and necessary valves and pressure gauges between:
   1. The engine and the day tank as shown on the drawings.
   2. Connections at the engine shall be made with flexible piping suitable for the fuel furnished.

2.6 ENGINE COOLING SYSTEM

A. Liquid-cooled, closed loop, with radiator mounted on the engine generator set and integral engine driven circulating pump.

B. Cooling capacity shall not be less than the cooling requirements of the engine-generator set and its lubricating oil while operating continuously at 110 percent of its specified rating.

C. Water circulating pumps shall be the centrifugal type driven by engine. Incorporate pressure relief devices, where required, to prevent excessive pressure increase after the engine stops.

D. Coolant shall be extended life antifreeze solution, 50 percent ethylene and 50 percent soft water, with corrosion inhibitor additive as recommended by the manufacturer

E. Radiator core tubes material shall be as recommended by the engine manufacturer.

F. Coolant hoses shall be flexible per manufacturer's recommendation.

G. Self-contained thermostatic-control valve shall modulate coolant flow to maintain optimum constant coolant temperature as recommended by the engine manufacturer.

2.7 AIR INTAKE AND EXHAUST SYSTEMS

A. Air Intake:
   1. Provide an engine-mounted air cleaner with replaceable dry filter and dirty filter indicator.

B. Exhaust System:
   1. Exhaust Muffler:
      a. Shall be Critical grade type and capable of the following noise attenuation:

<table>
<thead>
<tr>
<th>Octave Band Hertz (Mid Frequency)</th>
<th>Minimum db Attenuation (.0002 Microbar Reference)</th>
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<tr>
<td>31</td>
<td>5</td>
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2. Pressure drop in the complete exhaust system shall be small enough for satisfactory operation of the engine-generator set while it is delivering 110 percent of its specified rating.
3. Exhaust pipe size, from the engine to the muffler, shall be as recommended by the engine manufacturer. Pipe size from muffler to air discharge shall be two-pipe sizes larger than engine exhaust pipe.
4. Connections at the engine exhaust outlet shall be made with a flexible exhaust pipe. Provide bolted type pipe flanges welded to each end of the flexible section.

C. Condensate drain at muffler shall be made with schedule 40 black steel pipe through a petcock.

D. Exhaust Piping and Supports: Black steel pipe, ASTM A-53 standard weight with welded fittings. Spring type hangers, shall support the pipe.

E. Insulation for Exhaust Pipe and Muffler:
   1. Calcium silicate minimum 75 mm (3 inches) thick.
   2. The installed insulation shall be covered with aluminum jacket 0.4 mm (0.016 inch) thick. The jacket is to be held in place by bands of (0.38 mm) (0.015 inch) thick by 15 mm (0.5 inch) wide aluminum.
   3. Insulation and jacket are not required on flexible exhaust sections.

2.8 ENGINE STARTING SYSTEM

A. Shall start the engine at any position of the flywheel.

B. Electric cranking motor:
   1. Shall be engine-mounted.
   2. Shall crank the engine via a gear drive.
   3. Rating shall be adequate for cranking the cold engine at the voltage provided by the battery system, and at the required RPM during five consecutive starting attempts of 10 seconds cranking each at 10 second intervals, for a total of 50 seconds of actual cranking without damage.

C. Batteries

Battery: A lead-acid storage battery set of the heavy-duty diesel starting type shall be provided. Battery voltage shall be compatible with the starting system. Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.

Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.

Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
1. Each battery cell shall have minimum and maximum electrolyte level indicators, and flip top flame arrestor vent cap.
2. Batteries shall have connector covers for protection against external short circuits.
3. With the charger disconnected, the batteries shall have sufficient capacity so that the total system voltage does not fall below 85 percent of the nominal system voltage with the following demands:
   a. Five consecutive starting attempts of 10 seconds cranking at 10 second intervals for a total of 50 seconds of actual cranking (the fifth starting attempt will be manually initiated upon failure of a complete engine cranking cycle).
4. Battery racks shall be metal with an alkali resistant finish and thermal insulation, and secured to the floor.
5. Battery shall operate continuously for 12 hours and be able to provide the cranking power described in 2.8.B.3 without charging.

**D. Battery Charger:**
1. The charger shall maintain one percent voltage regulation from no load to full load for line voltage variation of 10 percent and frequency variation of ± 3 Hz from 60 Hz.
2. The charger shall maintain a nominal float voltage of 1.4 vdc and a nominal equalizing voltage of 1.6 vdc.
3. The charger shall be capable of continuous operation in an ambient temperature of –20 to 60 degrees C (–30 to 104 degrees F) without derating. The charger shall be convection cooled and housed in a NEMA 250, Type 1 enclosure. The charger shall have a hinged front door and all components shall be accessible from the front.
4. Provide both AC and DC transient protection. Charger shall be able to recharge a fully discharged battery without tripping AC protective devices. AC circuit breaker shall not trip under any DC load condition including short circuit on output terminals.
5. The charger shall be capable of recharging the fully discharged battery in 12 hours and simultaneously power the Supervisory and Control panel.
6. The charger shall have fused AC input and DC output protection, and shall not discharge the batteries when AC power fails.
7. The charger shall have the following accessories:
   a. On-Off control switch with pilot light.
   b. AC power failure alarm light.
   c. High DC voltage alarm light.
   d. DC voltmeter – 5 percent accuracy.
   e. DC Ammeter – 5 percent accuracy.

**2.9 GENERATOR**

A. Synchronous, amortisseur windings, bracket-bearing, self-venting, rotating-field type connected directly to the engine.
B. Integral poles and spider, or individual poles dove-tailed to the spider.
C. Designed for sustained short circuit currents in conformance with NEMA Standards.
D. Designed for sustained operation at 125 percent of the RPM specified for the generator set without damage.
E. Telephone influence factor shall conform to NEMA Standards.
F. Furnished with brushless excitation system or static-exciter-regulator assembly.
G. Nameplates attached to the generator and exciter shall show the manufacturer's name, equipment identification, serial number, voltage ratings, field current ratings, KW/KVA output ratings, power factor rating, time rating, temperature rise ratings, RPM ratings, full load current rating, number of phases and frequency, and date of manufacture.

H. At full load, the efficiency shall be not less than:
   1. 92 percent for sets specified over 175 KW.

I. The neutral shall be electrically isolated from equipment ground and terminated in the same junction box as the phase conductors.

J. The alternator shall not be oversized more than one size.

K. Each step load shall have a maximum of 15% voltage and frequency dip upon starting.

2.10 GENERATOR CONTROL PANEL

A. Controls – Generator Set Mounted
   1. Provide a fully solid-state, microprocessor based, generator set control. The control panel shall be designed and built by the engine manufacturer. The control shall provide all operating, monitoring, and control functions for the generator set. The control panel shall provide real time digital communications to all engine and regulator controls via SAE J1939.

B. Environmental
   1. The generator set control shall be tested and certified to the following environmental conditions:
      a. -40°C to +70°C Operating Range
      b. 100% condensing humidity, 30°C to 60°C
      c. IP22 protection for rear of controller; IP55 when installed in control panel
      d. 5% salt spray, 48 hours, +38°C, 36.8V system voltage
      e. Sinusoidal vibration 4.3G's RMS, 24-1000Hz
      g. Shock: withstand 15G

C. Functional Requirements
   1. The following functionality shall be integral to the control panel.
      a. The control shall include a minimum 33 x 132 pixel, 24mm x 95mm, positive image, transflective LCD display with text based alarm/event descriptions.
      b. The control shall include a minimum of 3-line data display
      c. Audible horn for alarm and shutdown with horn silence switch
      d. Standard ISO labeling
      e. Multiple language capability
      f. Remote start/stop control
      g. Local run/off/auto control integral to system microprocessor
      h. Cooldown timer
      i. Speed adjust
      j. Lamp test
k. Emergency stop push button
l. Voltage adjust
m. Voltage regulator V/Hz slope - adjustable
n. Password protected system programming

D. Digital Monitoring Capability
1. The controls shall provide the following digital readouts for the engine and generator. All readings shall be indicated in either metric or English units
   a. Engine
      Engine oil pressure
      Engine oil temperature
      Engine coolant temperature
      Engine RPM
      Battery volts
      Engine hours
      Engine crank attempt counter
      Engine successful start counter
      Service maintenance interval
      Real time clock
      Engine exhaust stack temperature
      Engine main bearing temperature
   b. Generator
      Generator AC volts (Line to Line, Line to Neutral and Average)
      Generator AC current (Avg and Per Phase)
      Generator AC Frequency
      Generator kW (Total and Per Phase)
      Generator kVA (Total and Per Phase)
      Generator kVAR (Total and Per Phase)
      Power Factor (Avg and Per Phase)
      Total kW-hr
      Total kVAR-hr
      % kW
      % kVA
      % kVAR
      Generator bearing temperature
      Generator stator winding temperature
   c. Voltage Regulation
      Excitation voltage
      Excitation current

E. Alarms and Shutdowns
1. The control shall monitor and provide alarm indication and subsequent shutdown for the following conditions. All alarms and shutdowns are accompanied by a time, date, and engine hour stamp that are stored by the control panel for first and last occurrence:
   a. Engine Alarm/Shutdown
      Low oil pressure alarm/shutdown
      High coolant temperature alarm/shutdown
Loss of coolant shutdown
Overspeed shutdown
Overcrank shutdown
Emergency stop shutdown
Low coolant temperature alarm
Low battery voltage alarm
High battery voltage alarm
Control switch not in auto position alarm
Battery charger failure alarm

b. Generator Alarm/Shutdown
   Generator phase sequence
   Generator over voltage
   Generator under voltage
   Generator over frequency
   Generator under frequency
   Generator reverse power (real and reactive)
   Generator overcurrent

c. Voltage Regulator Alarm/Shutdown
   Loss of excitation alarm/shutdown
   Instantaneous over excitation alarm/shutdown
   Time over excitation alarm/shutdown
   Rotating diode failure
   Loss of sensing
   Loss of PMG

F. Inputs and Outputs
1. Programmable Digital Inputs
   a. The Controller shall include the ability to accept programmable digital input signals. The
      signals may be programmed for either high or low activation using programmable Normally
      Open or Normally Closed contacts.

2. Programmable Relay Outputs
   a. The control shall include the ability to operate programmable relay output signals, integral
      to the controller. The output relays shall be rated for 2A @ 30VDC and consist of six (6)
      Form A (Normally Open) contacts and two (2) Form C (Normally Open & Normally
      Closed) contacts.

3. Programmable Discrete Outputs
   a. The control shall include the ability to operate two (2) discrete outputs, integral to the
      controller, which are capable of sinking up to 300mA.

4. Provide a cell phone auto dialer to report trouble and alarm conditions.

G. Maintenance
1. All engine, voltage regulator, control panel and accessory units shall be accessible through a single
   electronic service tool. The following maintenance functionality shall be integral to the generator
   set control
   a. Engine running hours display
   b. Service maintenance interval (running hours or calendar days)
   c. Engine crank attempt counter
d. Engine successful starts counter
e. 40 events are stored in control panel memory
f. Programmable cycle timer that starts and runs the generator for a predetermined time. The timer shall use 7 user-programmable sequences that are repeated in a 7-day cycle. Each sequence shall have the following programmable set points:

  Day of week
  Time of day to start
  Duration of cycle

H. Remote Communications
1. The control shall include Modbus RTU communications as standard via RS-485 half duplex with configurable baud rates from 2.4k to 57.6k.

I. Remote Monitoring Software
1. The control shall provide Monitoring Software with the following functionality
   a. Monitor up to eight (8) generator sets, plus ATS and UPS.
   b. Provide access to all date and events on generator set communications network
   c. Provide remote control capability for the generator set(s)
   d. Ability to communicate via Modbus RTU or remote modem
   e. Provide a cell phone auto dialer to report trouble and alarm conditions.

J. Local Annunciator (NFPA 99/110, CSA 282)
1. Provide a local, control panel mounted, annunciator to meet the requirements of NFPA 110, Level 1.
   a. Annunciators shall be networked directly to the generator set control
   b. Local Annunciator shall include a lamp test pushbutton, alarm horn and alarm acknowledge pushbutton
   c. Provide the following individual light indications for protection and diagnostics
      Overcrank
      Low coolant temperature
      High coolant temperature warning
      High coolant temperature shutdown
      Low oil pressure warning
      Low oil pressure shutdown
      Overspeed
      Low coolant level
      EPS supplying load
      Control switch not in auto
      High battery voltage
      Low battery voltage
      Battery charger AC failure
      Emergency stop
      Spare
      Spare

K. Remote Annunciator (NFPA 99/110, CSA 282)
1. Provide a remote annunciator to meet the requirements of NFPA 110, Level 1.
a. The annunciator shall provide remote annunciation of all points stated above and shall incorporate ring-back capability so that after silencing the initial alarm, any subsequent alarms will sound the horn.
b. Ability to be located up to 4000 ft from the generator set Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.11 SOUND ATTENUATED ENCLOSURE

A. The emergency generator set and related equipment shall be housed in an outdoor weatherproof enclosure. The generator will function properly without overheating in the ambient conditions specified. Enclosure shall be weatherproof and sound attenuated at a maximum 75 dBA at 7 meters. Sound ratings shall be based on full load condition of engine/generator in a single unit operation condition. Airflow configuration of the unit will be intake through rear of unit and discharge air vertically up. Enclosure shall be suitable for winds up to 193 kmh (120 mph); roof load shall be equal to or greater than 200 kg/sq m (40 lbs per sq. ft). Non-distributed loading as required.

B. The enclosure shall meet the following requirements:
   1. The exterior finish shall be guaranteed for a period of 10 years to be free from any defects when properly maintained.
   2. Enclosure shall be of sufficient size allowing for code clearances and proper servicing isles without removal or opening of enclosure panels.
   3. Radiator exhaust outlet shall be ducted through the end of the enclosure.
   4. All exterior surfaces shall be factory painted with industrial enamel.
   5. Unit shall have sufficient guards to prevent entrance by small animals.
   6. Batteries to fit inside enclosure and along side the engine provide protective shield. (Batteries under the generator are not acceptable.)
   7. Exhaust System: The silencer shall be critical grade, mounted and thermally insulated inside the enclosure. Insulation must be provided for the silencer, flex and all discharge piping. The weight of the silencer shall not be supported by engine. The exhaust pipe size shall be sufficient to insure that exhaust backpressure does not exceed the maximum limitations specified by the engine manufacturer. The exhaust silencer outlet roof penetration shall be sealed to prevent the entrance of rain, snow and sleet. A stainless steel bellowed flex shall be provided.

2.12 SPARE PARTS

A. For each engine-generator set:
   1. Six lubricating oil filters.
   2. Six primary fuel oil filters.
   4. Six intake air filters.

B. For each battery charger:
   1. Three complete sets of fuses.
   2. One complete set of indicating lamps.

C. For each control and supervisory panel:
   1. Three complete sets of fuses.
   2. One complete set of indicating lamps.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install concrete bases, per the seismic requirements for the site.

B. Installation of the engine generator set shall comply with manufacturer's written instructions and with NFPA 110.

C. Mounting:
   1. Support the base of engine-generator set on vibration isolators, each isolator bolted to the floor (pad), generator base bolted to isolator.
   2. Install sufficient number of isolators so that the floor (pad) bearing pressure under each isolator is within the floor (pad) loading specification.
   3. Install equal number of isolators on each side of the engine-generator set's base.
   4. Locate isolators for approximately equal load distribution and deflection per isolator. Base of the engine-generator set shall be drilled at the factory for the isolator bolts.
   5. Isolators shall be shipped loose with the engine-generator set.
   6. All connections between the engine-generator set and exterior systems, such as fuel lines, electrical connections, and engine exhaust system and air exhaust shroud, shall be flexible.

D. Balance:
   1. The vibration velocity in the horizontal, vertical, and axial directions shall not exceed 16.25 mm (0.65 inch) per second peak at any specific frequency. These limits apply to main structural components such as the engine block and the generator frame at the bearings.
   2. Balance the engine-generator set statically and dynamically at the factory in order to comply with the maximum specified vibration velocity.

E. Connect all components of the essential electrical power system so that they will continue to be energized by the auxiliary electrical power system during failures of the normal electrical power supply system.

F. Install piping between engine and remote components of cooling, fuel and exhaust systems.

G. Flexible connection between radiator and exhaust shroud at the wall damper:
   1. Install noncombustible flexible connections made of 20-ounce neoprene-coated fiberglass fabric approximately 150 mm (six inches) wide.
   2. Crimp and fasten the fabric to the sheet metal with screws 50 mm (two inch) on center. The fabric shall not be stressed, except by the air pressure.

H. Exhaust System Insulation:
   1. Adhesive and insulation materials shall be applied on clean, dry surfaces from which loose scale, and construction debris has been removed by wire brushing.
   2. Fill all cracks, voids and joints of applied insulation material with high temperature 1093 degrees C (2000 degrees F) insulating cement before applying the outer covering.
   3. The installation shall be neat, thermally and structurally tight without sag, neatly finished at all hangers or other penetrations and shall provide a smooth finish surface.
   4. Insulation and jacket shall terminate hard and tight at all anchor points.
   5. Insulate completely from engine exhaust flexible connection through roof or wall construction, including muffler.
3.2 START UP AND TESTING

A. Provide the services of a factory-authorized, factory-trained representative of the engine-generator set manufacturer to inspect field-assembled components, and equipment installation and supervise the field tests.

B. When the complete auxiliary electrical power system has been installed and prior to the final inspection, tests all components of the system in the presence of the Resident Engineer for proper operation of the individual components and the complete system and to eliminate electrical and mechanical defects.

C. Field Tests for the Engine-Generator Set:
   1. Test the engine generator set for eight hours of continuous operation as follows:
      a. First six hours while the set is delivering 100 percent of its specified KW rating.
      b. If during the 6-hour continuous test a failure occurs, either the engine shuts down or the full KW rating of the load bank is not achieved, the test is null and void. The test(s) shall be repeated until the satisfactory results are attained at no additional cost to the owner.
      c. Provide a portable load bank test for the generator.
   2. Record the following test data at 30-minute intervals:
      a. Time of day, also reading of running time indicator.
      b. KW.
      c. Voltage on each phase.
      d. Amperes on each phase.
      e. Engine RPM.
      f. Frequency.
      g. Engine water temperature.
      h. Fuel pressure
      i. Oil pressure.
      j. Outdoor temperature
      k. Average ambient temperature in the vicinity of the engine.
      l. Average ambient temperature in the vicinity of the starting batteries.
   3. Demonstrate that the generator set will attain proper voltage, frequency and will accept 100 percent block load within 10 seconds from a cold start after the closing of a single contact.
   4. Demonstrate a functional performance test with a simulated loss of normal power to the building. The Engineer and commissioning agent shall witness test. (use the building load)
   5. Demonstrate a functional performance test to the AHJ. (use the building load)

D. Battery and Starting System Test:
   1. Demonstrate that the batteries and cranking motor are capable of 5 starting attempts of 10 second cranking each at 10 second intervals with the battery charger turned off.

E. Test local and remote panels: Simulate engine failures while checking for proper operation of each indicating lamp, alarm device and reset button.

F. When any defects are detected during the tests, correct all the deficiencies and repeat all or part of the 8-hour continuous test as requested by the owner, at no additional cost.

G. Provide test and inspection results in writing to the engineer.

END OF SECTION 263200
SECTION 263600 – TRANSFER Switches

PART 1 - GENERAL

1.1 SUBMITTALS

A. See section 260510.

1.2 QUALITY ASSURANCE

A. Furnish and install the low voltage transfer switches having ratings, features/accessories and enclosures as specified herein and as shown on the contract drawings.

B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years.

D. Factory authorized representative shall maintain a service center capable of providing emergency maintenance and repair services at the project site within 4 hour maximum response time.

E. Automatic transfer switch, bypass/isolation switch shall be products of same manufacturer.

1.3 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only:

B. Institute of Electrical and Electronic Engineers (IEEE):

446-95 ......................................Recommended Practice for Design and Maintenance of Emergency and Standby Power Systems
C37.90.1-02 ..............................IEEE Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems

C. National Electrical Manufacturers Association (NEMA):

250-03 ......................................Enclosure for Electrical Equipment (1000 Volts Maximum).
ICS 6-01 ......................................Industrial Control and Systems Enclosures
IC3 4 ......................................Industrial Control and Systems: Terminal Blocks
MG 1-03 ......................................Motors and Generators, Revision 1

D. National Fire Protection Association (NFPA):

70–05 ......................................National Electrical Code (NEC)
110 ......................................Emergency and Standby Power Systems

E. Underwriters Laboratories, Inc. (UL):

50-03 ......................................Enclosures for Electrical Equipment
508-02 ......................................Industrial Control Equipment
891-03 ......................................Dead-Front Switchboards
PART 2 - PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCHES

A. General:
1. Comply with UL, NEMA, NEC, ANSI and NFPA.
2. Automatic transfer switches are to be electrically operated, mechanically held open contact type, without integral overcurrent protection. Transfer switches utilizing automatic or non-automatic molded case circuit breakers as switching mechanisms are not acceptable.
3. The unit shall be completely factory-assembled and wired so that only external circuit connections are required in the field. The unit shall include, but not be limited to, operating mechanism, main contacts, auxiliary contacts, timers, pilot lights, switches, and auxiliary sensing devices.
4. Each transfer switch shall be equipped with bypass/isolation switch. The switch shall be part of the transfer switch.
5. Acceptable manufacturers, contingent upon compliance with the contract documents, are as listed below. Bidders shall carefully review the requirements listed in the technical specifications and only submit products that are equal or better. Equal products by other manufacturers are acceptable providing substitutions are submitted in accordance with requirements listed in the “Instructions to Bidders” and “Supplemental Instructions to Bidders” (SCOSE AIA A701) and approved by the A/E. Bidders shall carefully review the front end documents (SCOSE AIA A701) and submit all information required to allow the A/E the ability to make a fully informed decision.
   a. GE
   b. Square D
   c. ASCO
   d. Siemens
   e. Cutler Hammer
   f. Russ Electric
   g. Cummins (when provided with associated generator)
   h. Caterpillar (when provided with associated generator)

B. Ratings, Markings and Tests:
1. Ratings:
   a. Phase, voltage, ampere rating, number of poles, withstand rating shall be as shown on the drawings. The ampere rating shall be for 100 percent continuous load current.
   b. Transfer switches are to be rated for total system transfer on emergency systems.
   c. Ratings shall be with non-welding of contacts during the performance of withstand and closing tests.
2. Markings:
   a. Markings shall be in accordance with UL 1008.
   b. Markings for the additional withstand test hereinafter specified shall be included in the nameplate data.
3. Tests:
   a. Transfer switches shall be tested in accordance with UL 1008. The contacts of the transfer switch shall not weld during the performance of withstand and closing tests when used with the upstream overcurrent device.

C. Housing:
1. Enclose transfer switches in steel cabinets in accordance with UL 508, or in a switchboard assembly in accordance with UL 891, as shown on the drawings. NEMA ICS 6 Type.
2. Doors: Shall have three-point latching mechanism.
3. Padlocking Provisions: Provide chain for attaching a padlock. Attach chain to the cabinet by welding or riveting.
4. Finish: Cabinets shall be given a phosphate treatment, painted with rust inhibiting primer, and finish painted with the manufacturer's standard enamel or lacquer finish.

2.2 FEATURES

A. Transfer switches shall include the following features:

1. Operating Mechanism:
   a. Actuated by an electrical operator.
   b. Electrically and mechanically interlocked so that the main contact cannot be closed simultaneously in both normal and emergency position.
   c. Normal and emergency main contacts shall be mechanically locked in position by the operating linkage upon completion of transfer. Release of the locking mechanism shall be possible only by normal operating action.
   d. Shall not include a neutral position.
   e. Contact transfer time shall not exceed six cycles.
   f. Do not use as a current carrying part. Components and mechanical interlocks shall be insulated or grounded.

2. Contacts:
   a. For switches 400 amperes and larger, protect main contacts by separate arcing contacts and magnetic blowouts for each pole. Arc quenching provisions equivalent to magnetic blowouts will be considered acceptable.
   b. Current carrying capacity of arcing contacts shall not be used in the determination of the transfer switch rating, and shall be separate from the main contacts.
   c. Main and arcing contacts shall be visible for inspection with cabinet door open and barrier covers removed.

3. Manual Operator:
   a. Capable of operation in either direction under no load.
   b. Capable of operation by one person.
   c. Provide a warning sign to caution against operation when energized.

4. Replaceable Parts:
   a. Include the main and arcing contact individually or as units, relays, and control devices.
   b. Switch contacts and accessories are to be replaceable from the front without removing the switch from the cabinet and without removing main conductors.

5. Sensing Relays:
   a. Provide voltage-sensing relays in each phase of the normal power supply.
   b. Provide adjustable voltage and frequency sensing relays in one phase of the auxiliary power supply.

6. Controls:
   a. Control module shall provide indication of switch status—emergency, normal, and be equipped with alarm diagnostic circuitry.
   b. Control module shall control operation of the transfer switch. The sensing and the logic shall be controlled by a microprocessor equipped with digital communication and battery backup. The control shall comply with IEEE 472.

2.3 ACCESSORIES

A. Transfer switches shall include the following accessories:

1. Indicating Lights of different colors:
   a. Green Signal light for normal source position.
   b. Red Signal light for emergency source position.
2. Laminated black phenolic nameplates with white letters to indicate transfer switch position.

B. Manual Test Switch for simulating normal source failure.

C. Engine starting contacts.

D. Time delay relay to accomplish the function as specified.

E. Auxiliary Contacts:
   1. Provide contacts for connection to elevator controllers, one closed when transfer switch is connected to normal, and one closed when transfer switch is connected to emergency.
   2. Provide additional contacts as necessary to accomplish the functions shown on the drawings, specified, and designated in other sections of these specifications and one spare normally open and normally closed contact.
   3. Contacts shall have a minimum rating of ten amperes and be positive acting on pickup and dropout.

F. Remote Indicators:
   1. Provide remote pilot lamps to show transfer switch position.
   2. Provide remote manual test switch to simulate normal source failure.
   3. Provide remote contact to bypass retransfer time delay to normal source //.

G. In-Phase Band Monitor: Monitor shall control the operation of the transfer switch. It shall monitor the voltage and frequency of the normal and emergency voltage //.

H. Auxiliary Relay: Provide an auxiliary pre-signal relay on all automatic transfer switches, which will feed elevator loads for use as elevator control.

2.4 TRANSFER SWITCH OPERATION

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

B. The transfer switch shall transfer the load from normal to emergency source when the frequency and voltage of the engine-generator unit have attained 90 percent of rated value.

C. The transfer switch shall retransfer the load from emergency to normal source upon restoration of normal supply in all phases to 90 percent or more of normal voltage, and after a time delay. The time delay shall be field adjustable from five to twenty-five minutes (preset for twenty-five minutes). Should the emergency source fail during this time, the transfer switch shall immediately transfer to the normal source whenever it becomes available. After restoring to normal source, the generator shall continue to run for five minutes unloaded before shut down. Time delay shall be adjustable from zero to fifteen minutes. //

D. Engine Start: A voltage decrease, at any transfer switch, in one or more phases of the normal power source to less than 70 percent of normal shall start the engine-generator unit after a time delay of two to three seconds. The time delay shall be field adjustable from zero to fifteen seconds.

E. Transfer to Emergency (Emergency System Loads): Transfer switches for emergency system loads shall transfer their loads from normal to emergency source when frequency and voltage of the engine-
generator unit have attained 90 percent of rated value. Only those switches with deficient normal source voltage shall transfer.

F. Transfer to Emergency (Equipment System Loads): Transfer switches for equipment system loads shall transfer their loads to the generator on a time delayed staggered basis, after the emergency system switches have transferred. Total delayed transfer time of an equipment system switches shall not exceed two minutes. Time-delay relays shall be field adjustable zero to two minutes.

G. Retransfer to Normal (All Loads): Transfer switch shall retransfer the load from emergency to normal source upon restoration of normal supply in all phases to 90 percent or more of normal voltage, and after a time delay. The time delay shall be field adjustable from five to twenty-five minutes (preset for twenty-five minutes). Should the emergency source fail during this time, the transfer switch shall immediately transfer to the normal source whenever it becomes available. After restoring to normal source, the generator shall continue to run for five minutes unloaded before shut down. Time delay shall be adjustable from zero to fifteen minutes.

H. Exercise Mode: Transfer to emergency power source shall be accomplished by remote manual test switches on a selective basis.

2.5 BYPASS/ISOLATION SWITCHES (BP/IS)

A. Provide two-way bypass/isolation manual type switches. The BP/IS shall permit load by-pass to either normal or emergency power source and complete isolation of the transfer switch, independent of transfer switch position. The switches shall conveniently and electrically bypass and isolate automatic transfer switches, which could not otherwise be safely maintained without disruption of critical loads. Bypass and isolation shall be possible under all conditions including where the automatic transfer switch may be removed from service. Bypass/Isolation switches shall comply with NFPA 110, and shall be factory tested.

B. Operation: The bypass/isolation switch shall have provisions for operation by one person through the movement of a maximum of two handles at a common dead front panel in no more than 15 seconds or less. Provide a lock, which must energize to unlock the bypass switch, to prevent bypassing to a dead source. Provide means to prevent simultaneous connection between normal and emergency sources.

1. Bypass to normal (or emergency): Operation of bypass handle shall allow direct connection of the load to the normal (or emergency) source, without load interruption or by using a break-before-make design, or provide separate load interrupter contacts to momentarily interrupt the load.
   a. Assure continuity of auxiliary circuits necessary for proper operation of the system.
   b. A red indicating lamp shall light when the automatic transfer switch is bypassed.
   c. Bypassing source to source: If the power source is lost while in the bypass position, bypass to the alternate source shall be achievable without re-energization of the automatic transfer switch service and load connections.

2. Isolation: Operation of the isolating handle shall isolate all live power conductors to the automatic transfer switch without interruption of the load.
   a. Interlocking: Provide interlocking as part of the bypass/ isolation switch to eliminate personnel-controlled sequence of operation, and to prevent operation to the isolation position until the bypass function has been completed.
   b. Padlocking: Include provisions to padlock the isolating handle in the isolated position.
   c. Visual verification: The isolation blades shall be visible in the isolated position.

3. Testing: It shall be possible to test (normal electrical operation) the automatic transfer switch and engine generator with the isolation contacts closed, and the load bypassed without interruption of power to the load.
C. Ratings: The electrical capabilities and ratings of the bypass/isolation switch shall be compatible with those of the associated automatic transfer switch, including any required additional withstand tests.

D. Enclosure Construction: Enclosure construction shall be in accordance with UL standards. The bypass/isolation switch shall be mounted in a separate enclosure or separate compartment from the automatic transfer switch. NEMA ICS 6 enclosure rating shall match automatic transfer switch.

E. Diagrams: The manufacturer shall provide specific information on the interconnection and installation of the bypass/isolation switch and automatic transfer switch.

F. The bypass/isolation switch shall also meet all the requirements as specified for an automatic transfer switch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install automatic transfer switch(s) in accordance with the NFPA and as shown on the drawings.

B. Level and anchor the automatic transfer(s) switch to floor or wall.

C. Ground equipment as shown on the drawings and as required by NFPA 70.

3.2 START UP AND TESTING

A. After the complete system has been installed, and before energizing the system, check all components of the system, including insulation resistance, phase to phase and phase to ground, complete electrical circuitry and safety features according to the manufacturer’s written instructions.

B. After energizing circuits, test the interlocking sequence and operation of the complete system, including time delays of transfer from normal source to emergency and back to normal source, pick-up and voltage drop, and function of bypass/isolation switch in the presence of the Resident Engineer prior to the final inspection.

C. When any defects are detected, correct the defects and repeat the test as requested by the Resident Engineer, at no additional cost to the owner.

END OF SECTION 263600
SECTION 265100 – LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the requirements for the following:
   1. Interior luminaires and accessories.
   2. Emergency lighting units.
   3. Exit signs.
   4. Lamps.
   5. Luminaire accessories.

1.2 SUBMITTALS

A. Refer to section 260510.

1.3 QUALITY ASSURANCE

A. Conform to requirements of ICC and NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 REFERENCE STANDARDS


F. IESNA LM-80-08 – Approved Method: Measuring Lumen Maintenance of LED Light Sources.


H. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; current edition.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of design is as scheduled on drawings. Equal products by other manufacturers are acceptable providing substitutions are submitted in accordance with requirements listed elsewhere in the Bid Documents and approved by the A/E.

B. Equal Manufacturer(s) are listed in lighting fixture schedule on drawings.

C. LM-79 reports must be submitted with all proposed LED substitutions from those listed in the Light Fixture Schedule.

2.2 LUMINAIRES

A. Furnish products as indicated in Schedule on plans.

2.3 LAMPS

A. Lamp Types: As specified for each luminaire.

B. Use lamp colors as indicated on the plans or to match existing lamp colors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fixtures securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting).

B. Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

C. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

D. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

E. Install recessed luminaires to permit removal from below.

F. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

G. Install clips to secure recessed grid-supported luminaires in place.

H. Install wall mounted luminaires, emergency lighting units, and exit signs at height as indicated on Drawings.

I. Install accessories furnished with each luminaire.

J. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

K. Bond products and metal accessories to branch circuit equipment grounding conductor.
L. Install specified lamps in each emergency lighting unit, exit sign, and luminaire.

3.2 FIELD QUALITY CONTROL
A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING
A. Aim and adjust luminaires as indicated.
B. Position exit sign directional arrows as indicated.

3.4 CLEANING
A. Clean electrical parts to remove conductive and deleterious materials.
B. Remove dirt and debris from enclosures.
C. Clean photometric control surfaces as recommended by manufacturer.
D. Clean finishes and touch up damage.

3.5 CLOSEOUT ACTIVITIES
A. Demonstrate luminaire operation for minimum of two hours.

3.6 PROTECTION
A. Replace/Repair luminaires that have failed at Substantial Completion.

END OF SECTION 265100