SECTION 26 01 00 - GENERAL PROVISIONS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Switchboards.

B. Secondary power wiring and distribution system.

C. Emergency power generation system.

D. Lightning protection system.

E. Fire alarm system.

F. Telephone system.

G. Security system.

H. Lighting control equipment.

I. Electrical control systems and interlock wiring.

J. Intercommunication system.

K. CCTV system.

1.2 RELATED WORK

A. Foundations and pads required for equipment furnished under this division of the specifications.

B. Field painting, except such painting as is required to maintain shop coat painting and factory finish painting.

C. Electrical control systems and interlock wiring as required by mechanical drawings, specifications or manufacturer's schematics.

D. Flashing of conduits into roofing and outside walls.

E. Heating, ventilating, and air conditioning equipment.

F. Plumbing equipment.

G. Fuel oil storage tank and fuel transfer pumping system.

1.3 QUALITY ASSURANCE

A. Comply with applicable local, state and federal codes.

B. Comply with applicable requirements of recognized industry associations which promulgate standards for the various trades.

C. Employ only qualified journeymen for this work. Employ a competent qualified electrician to supervise the work.

1.4 STANDARDS

A. Perform work specified in Division 26 in accordance with standards listed below including amendments or revisions. When these specifications are more stringent, they take precedence. In case of conflict, obtain a decision from the Designer.

B. National Fire Codes (NFPA) including, but not limited to following:

1. NFPA-70 - National Electrical Code. [2023] Edition.
2. NFPA-72 - National Fire Alarm Code. [2025] Edition.
3. NFPA-101 - Life Safety Code. [2024] Edition.
4. NFPA-780 - Lightning Protection Code. [2023] Edition.

C. Applicable Codes:

1. Mississippie Building Code [2024]
2. ANSI Handicapped Code - A117.1. [2017] Edition.
3. International Energy Code [2012] Edition.

D. Should any work be construed as being contrary to or not conforming to aforementioned codes, such alleged confliction to be brought to attention of Engineer in writing ten (10) days prior to bid date for review so that such point in question may be resolved. All work to be installed in strict conformity with applicable codes without additional cost to Owner.

E. Contractor to submit and/or file with proper authorities all necessary specifications and drawings as required by governing authorities.

1.5 SUBMITTALS

A. Submit individual submittals for each item or piece of equipment. Assign a separate submittal number and transmittal to each item. Do **NOT** group items or equipment together in one submittal, they will be rejected and returned without review.

B. Within fifteen (15) days after contract has been awarded, Contractor to submit to Designer for review a complete list of materials, equipment, and accessories proposed for use, listing the item and manufacturer's name only.

C. Based upon aforementioned approved listing, Contractor to submit One (1) electronic PDF copy of COMPLETE BROCHURES AND SHOP DRAWINGS OF ALL MATERIALS, FIXTURES, AND EQUIPMENT that he proposes to use giving the names of manufacturers, trade name and specific catalog numbers.

D. Brochures to be submitted in time to allow fifteen (15) days from date of receipt in Engineer's office before final approval or disapproval is required to meet construction schedule. Submittals to bear Contractor's stamp of approval evidencing he has examined and checked same and information contained therein is in accordance with contract requirements, and any deviations to be clearly marked. Approval of shop drawings not to be construed as permitting departure from the contractual documents.

E. Above-mentioned brochures to be submitted and approved before any materials are ordered.

F. In the event that within time stated above contractor fails to submit complete list of materials, equipment and accessories in proper form, the Designer reserves the right to select a full line of materials, fixtures, and equipment, which shall be binding upon Contractor for these materials, fixtures, and equipment as the case may be and which shall be used in his work.

G. Brochures: Submit complete descriptions, illustrations, specification data, etc. of all materials, fittings, devices, fixtures, special systems, etc., including the following:

1. Panelboards.
2. Wiring devices and plates.
3. Motor starters and contactors.
4. Disconnect switches.
5. Enclosed circuit breakers.
6. Transformers.
7. Lighting, including lamps.
8. Master clock system.
9. Security system.
10. Closed-circuit TV system.

H. Proposed items to be clearly indicated when other items are shown on same sheet. When proposing items other than those specified, brochures to contain both specified item sheets and proposed item sheets for ease of comparison. On request from Designer, samples shall be submitted and/or set up, as directed, for inspection and approval. Samples will be returned to Contractor.

I. Shop Drawings: Submit specific shop drawings for major materials including the following:

1. Fire alarms and smoke detection systems, including point-to-point wiring diagrams.
2. Emergency power generator system including automatic transfer switches.
3. Distribution switchboards.

4. Lightning protection system.
5. Dimensional layout of all electrical rooms, drawn to scale, with equipment location shown therein. Clearances to be in accordance with NEC and local codes.
6. Electrical Coordination Study submitted by switchboard manufacturer to include time-current curves and all related breaker data information. Coordination Study must be approved by the engineer prior to order of switchboard.

1.6 OPERATING AND MAINTENANCE MANUALS

A. Prior to final acceptance of the project, furnish to Owner complete bound sets of operation and maintenance manuals of instructions for operation and maintenance of all pieces of equipment and systems provided under this division of specifications.

B. Manuals to also include all submittal data on all materials and equipment. Clearly indicate items provided on this project. A list giving name and address of nearest supply house carrying spare parts and name of Installation Contractor to be given to Owner.

C. Verbally instruct Owner's representatives. Contractor to obtain letter signed by the owner's representative indicating that the in-service training has been completed.

D. Three sets of the following data are required:

1. Operating and maintenance instructions.
2. Spare parts lists.
3. Copies of approved submittal data.

E. Arrange each set of data in an orderly way, and bind each set in a separate 3-ring, hard-cover binder.

F. As soon as data accumulates, prepare one of the sets and deliver to the Owner's Representative, continuously updating this set as additional data is obtained.

G. At completion of work, submit two complete sets of data to the Owner's Representative for distribution to the proper parties.

H. Short Circuit, Protective Device Coordination and Arc Flash Study.

1.7 DELIVERY AND STORAGE

A. Insofar as possible, deliver items in manufacturers’ original unopened packaging. Where this is not practical, cover items with protective materials, to keep them from being damaged. Use care in loading, transporting, unloading, and storage to keep items from being damaged.

B. Store items in a clean dry place and protect from damage.

C. All damaged painted surfaces of equipment to be touched up to match original paint.

1.8 RECORD DRAWINGS

A. Keep a set of blueline prints at the job site exclusively for recording deviations from the drawings.

B. Record locations and depths of buried and concealed conduits from fixed easily identifiable objects, such as building walls. Where conduits are concealed in walls, indicate distances off of building corners or other building features not likely to be disturbed by future alterations.

C. Mark deviations in colored pencils so that work of various systems can be easily identified.

D. When work is completed, record all deviations on clean sepia copies of drawings.

E. Submit three sepia copies of completed "record drawings" to Owner's Representative for distribution.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. All materials and equipment used in carrying out these specifications to be American made unless approved otherwise by the Owner and to be new and have UL listing, or listing by other recognized testing laboratory when such listings are available. Specifications and drawings indicate name, type, and catalog numbers of materials and equipment to be used as "standards" shall not be construed as limiting competition. Contractor may at his option, use materials and equipment when, in the judgment of the Designer, they are equivalent to that specified.

PART 3 - EXECUTION

3.1 COORDINATION

A. Intent:

1. These sections of specifications and drawings form a complete set of documents for the electrical work of this project. Neither is complete without the other. Any item mentioned in one shall be as binding as though mentioned in both.
2. The intent of these specifications and drawings is to form a guide for a complete electrical installation. Where an item is reasonably necessary for a complete system but not specifically mentioned, such as pull boxes,

fittings, expansion fittings, support hangers, etc., provide same without additional cost to Owner.

3. Electrical layouts indicated on drawings are diagrammatical only. Exact location of outlets to be governed by project conditions. The Designer reserves the right to make any reasonable changes (approximately 6 feet) in location of junction boxes, or equipment prior to roughing-in of such without additional cost to Owner.

B. Deviations:

1. No deviations from specifications and drawings to be made without full knowledge and consent of Designer.
2. Should Contractor find during progress of work that existing conditions make desirable a modification of the requirements of any particular item, report such item promptly to Designer for his decision and instructions.

C. Insofar as it is possible to determine in advance, leave proper chases and openings. Place all outlets, anchors, sleeves, and supports prior to pouring concrete or installation of masonry work. Should contractor neglect doing this, any cutting and/or patching required to be done is at this contractor's expense.

D. Visit site and be informed of conditions under which work must be performed. No subsequent allowance will be made because of error or failure to obtain necessary information to completely estimate and perform work involved.

E. Designer to be mediating authority in all design related deviations and disputes arising on the project.

F. Coordinate to assure that proper points of service transformer locations, voltage characteristics and capacity of service are in accordance with contract drawings.

3.2 CUTTING AND PATCHING

A. Repair or replace routine damage caused by cutting in performance of this contract.

B. Correct unnecessary damage caused due to installation of electrical work, brought about through carelessness or lack of coordination.

C. Holes cut through existing floor slabs to be core drilled with drill designed for this purpose. All openings, sleeves and holes in slabs between floors to be properly sealed, fire proofed and water proofed.

D. Repairs to be performed with materials which match existing materials and to be installed in accordance with appropriate sections of these specifications.

3.3 TRENCHING, EXCAVATION, BACKFILLING, AND REPAIRS

A. Provide trenching, excavation, and backfilling necessary for performance of electrical work.

B. Trenching and excavation to be unclassified. No extra will be paid in event that rock is encountered.

C. Backfilling to be carefully done using only clean earth thoroughly tamped and compacted below and above embedded items.

3.4 FOUNDATIONS AND PADS

A. Provide foundations and pads required for equipment provided under this division of specifications. Coordinate proper size and location of foundations, pads, anchor bolts, and other items to be built into structure.

B. Concrete to be in accordance with concrete division of these specifications.

3.5 TESTS

A. On completion of work, installation to be entirely free from grounds, short circuits, and open circuits. Perform a thorough operational test in presence of Owner or his representative. Balance all circuits so that feeders to panels be not more than 10% out of balance between phases with all available load energized and operating. Furnish all labor, materials and instruments for above tests.

B. Furnish Owner, as a part of closing file, a copy of such tests including identification of each circuit and readings recorded, also the main service ground test as described in Section 26 05 26 of these specifications. Test information to be furnished to Owner includes ampere readings of all panels and major circuit breakers, insulation resistance reading of motors and transformers.

C. Prior to final observation and acceptance, test, leave in satisfactory operating condition all electrical systems and equipment including but not limited to the following:

1. Electrical distribution system.
2. Ground fault protection system.
3. Emergency power generation system.
4. Transformers.
5. Fire alarm and smoke detection system.
6. Electric motors for all equipment.
7. Master clock system.
8. Electric safety devices.
9. Any alarm system, including narcotics, generator, door security, etc.
10. Isolation panel ground monitor.
11. CCTV system.

3.6 INSPECTION FEES AND PERMITS

A. Obtain and pay for all necessary permits and inspection fees required for electrical installation.

3.7 IDENTIFICATION OF EQUIPMENT

A. Properly identify all starters, contactors, relays, safety switches and panels with permanently attached black (normal power) or red (essential systems) phenolic plates with 1/4" white engraved lettering on the face of each attached, with two sheet metal screws. Starters and relays connected by the electrical tradesman to be identified by him whether furnished by him or others.

3.8 TEMPORARY LIGHTS AND POWER

A. Provide a temporary electrical lighting and power distribution system of adequate size to properly serve the following requirements, including adequate feeder sizes to prevent excessive voltage drop. Temporary work to be installed in a neat and safe manner in accordance with the National Electrical Code, Article 590, and as required by OSHA or applicable local safety codes.

B. Provide one duplex power outlet for every 1,500 square feet of floor area, evenly distributed throughout the building. Power outlets to be 20 amp, single phase located as directed by the contractor.

C. Check with contractor prior to installation to determine if any lighting or power outlets over the maximum quantity noted above are required.

D. Provide service and panelboards required for above lighting and power outlets.

3.9 DEMOLITION

A. Contractor shall visit the site before submitting a bid to acquaint himself with existing conditions.

B. Work in existing buildings shall be scheduled well in advance with the Owner. Work shall be performed at such times and under such conditions as suit the convenience of the Owner. Plan the work to minimize disruption of formal operations.

C. In renovated areas, remove wiring devices, fixtures, components, electrical equipment, conductors, boxes, and conduits not required to remain in service when this project is complete.

D. Remove existing conduit and wire from areas to be remodeled, back to panelboard, cabinet or junction box.

E. Where a circuit is interrupted by removal of a device or fixture from that circuit, the contractor shall install wire, conduit, etc., as required to restore service to the remaining devices and fixtures on that circuit.

F. Lighting fixtures, wiring devices, panelboards, and conductors removed shall be offered to the Owner. If he chooses to retain these items or a part of these items, turn those chosen over to him. Items rejected by the Owner shall be removed from the project site by the contractor.

3.10 OBSERVATIONS

A. When field observation services are a part of the project scope, Engineer's office will provide periodic observation of the progress of work specified herein. Purpose of the observation is to ensure compliance of Contractor's work with specifications and drawings. Engineer's office will also observe tests required of Contractor as called for in other sections of specifications.

B. Specifications and drawings represent work to be done in view of total project requirements. Final location of conduits, fixtures, panels, switchboards, etc., to eliminate possible conflict with other trades is responsibility of Contractor. Contractor to provide all supervision required for his personnel to ensure that installation is made in accordance with specifications and drawings and all safety rules and regulations are observed. In event of conflicts of work on project with other trades, Contractor to make every reasonable effort to resolve conflict through meetings and discussions with other parties involved, by preparation of drawings or other appropriate action. Only after this has been done shall the Engineer's assistance be requested.

C. When Engineer is requested to visit project to aid in resolution of conflicts or for witnessing tests, he shall be given a minimum of 48 hours notice prior to time his presence is required at job site.

3.11 WARRANTY-GUARANTEE

A. Designer reserves right to accept or reject any part of installation which does not successfully meet requirements as set out in these specifications.

B. Contractor shall and hereby does guarantee all work installed under this division shall be free from defects in workmanship and materials for a period of one year from date of final acceptance, whichever is earliest. The above parties further agree that they will repair and replace any defective material or workmanship which becomes defective within the terms of this warranty-guarantee.

END OF SECTION 26 01 00

SECTION 26 05 01 - ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish all labor, equipment, materials and supplies necessary for and reasonably incidental to demolition of work hereinafter specified, indicated on drawings, required or intended for completion of the work.

B. Items included under demolition work include but are not limited to:

1. Telephone service.
2. Power service to the operations, administration and service buildings.

C. Repair those areas damaged under demolition work once new services and systems have been installed.

1.2 JOB CONDITIONS

A. Provide adequate protection to persons and property. Execute work in such a manner as to avoid interference with required operations and use of or passage to and from adjoining buildings and facilities.

B. Demolition work of equipment necessary for the operation of the power and communication systems to be coordinated with the installation of new equipment. The demolition and installation work is to be done as quickly as possible to minimize any burdens on the Owner.

1.3 CONDITION OF EXISTING FACILITIES

A. Contractor shall verify the areas, conditions and features necessary to tie new work into existing construction. This verification shall be done prior to submittal of shop drawings, fabrication of erection, construction or installation. The Contractor shall be responsible for the accurate tie-in of the new work to existing facilities.

PART 2 - PRODUCTS - NOT APPLICABLE.

PART 3 - EXECUTION

3.1 SCHEDULES

A. Schedule all demolition work as to cause minimal interference with plant operations and to comply with provisions of [**SUMMARY OF WORK: SECTION 01 10 00.**]

B. Obtain prior approval of the Owner at least seven days in advance before starting demolition of any equipment. Under no circumstances will demolition work be approved until new equipment is ready for installation.

3.2 PREPARATION

A. Disconnect or arrange for disconnection of utility service connections to equipment and areas to be demolished before starting demolition.

B. Preserve in operating condition all active utilities transversing the project site. Protect all equipment that remains (electrical and mechanical) during demolition, and repair all damage caused by this work to satisfaction of Designer.

3.3 APPLICATION

A. Maintain the continuity of the existing branch circuits serving all existing light fixtures that are to remain, whether indicated or not on the drawings.

B. All existing walls, ceilings, floor slabs, etc., being cut or damaged under this contract to be patched back to match existing by General Contractor.

C. All existing switchgear, lighting fixtures, receptacles, control equipment and switches being removed to be cleaned and turned over to the Owner.

D. Remove exposed ground conductor back to source or point of contact with slab. Cut conductor off below slab and abandon with hole being patched back to match existing surface (floor, wall or ceiling). If reusable, simply disconnect ground conductor.

E. Conduits, wire and wood products that are not salvageable shall be disposed of legally.

F. Primary work shall be completed with all facilities kept in service or with short periods of scheduled momentary outages.

G. Holes in slabs or into classified areas to be patched to provide a gas, vapor and watertight barrier.

3.4 STORAGE AND HANDLING

A. The Owner reserves the right to save materials that are a part of the demolition work, and the Contractor shall turn over and store any such materials at the Owner's direction.

B. All materials not turned over to Owner shall become property of Contractor and removed promptly from plant site at no additional cost to the Owner. Any permits or fees for disposal shall be the responsibility of the Contractor.

3.5 CLEANUP

A. Burn no materials or debris on premises.

B. Remove from site rubbish and debris found thereon and, except as otherwise specified, materials and debris resulting from work of demolition. Leave site in safe and clean condition.

END OF SECTION 26 05 01

SECTION 26 05 13 - MEDIUM VOLTAGE CONDUCTORS - 2.4 KV THROUGH 46KV

PART 1 - GENERAL

1.1 WORK INCLUDED

A. All work specified in this section shall comply with the provisions of Section 26 01 00.

B. Provide a complete system of conductors for medium voltage power as indicated on the drawings.

C. Refer to drawings for sizes of conductors.

1.2 REFERENCE STANDARDS

A. Shielded Conductors shall comply with the following standards:

1. UL 1072 - 2400 volt non-shielded solid-dielectric single conductor power cable Type MV-90 and 5KV-35KV shielded power cable Type MV-105.
2. ICEA S-93-639 for non-utility shielded power cables rated 5KV through 46KV.
3. ICEA S-97-682 for utility shielded power cables rated 5KV through 46KV.
4. ICEA S-94-649 for concentric neural cables rated 5 KV through 46KV.
5. AEIC CS8 - Ethylene propylene rubber insulated shielded power cables rated 5 KV through 69 KV.
6. IEEE 400.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS/EQUIPMENT

A. Okonite

B. Prysmian

C. Southwire.

D. General Cable Lead-Free Uniblend XLF.

E. WTEC

F. Approved equal.

2.2 IDENTIFICATION

A. The outer jacket of the cable shall be printed with the following information at two-foot intervals maximum in accordance with the NEC Article 310-11:

1. Manufacturer's name.
2. Conductor size.
3. Voltage rating.
4. "Direct Burial" (Multi-conductor only).
5. Identification of the insulation type.
6. "Sunlight-Resistant for CT USE", in accordance with the NEC Article 318.
7. Year and place of manufacturer.
8. UL Type MV-105. 2.4KV shall be rated MV90.

2.3 CONDUCTORS

A. Conductors to be annealed, Class B compact stranded copper per ASTM B-8, ICEA S-93-639, and ICEA S-97-682.

2.4 SCREEN

A. Strand screen to be thermoset extruded semiconducting compound, meeting the electrical and physical requirements of ICEA.

1. Strand screen is to be extruded semiconducting thermoset compound, applied over the conductor and uniformly bonded to the overlying EPR insulation, meeting the electrical and physical requirements of AEIC CS8, and UL 1072 (for power shielded cables).

2.5 INSULATION

A. Insulation to be a high quality heat, moisture, corona and ozone-resistant ethylene-propylene (EPR), thermosetting compound meeting or exceeding the electrical and physical requirements of ICEA S-93-639, ICEA-97-682, AEIC CS8 and UL 1072 (for power shielded cables).

B. The cable core shall be Discharge Free applying the strand screen, insulation and insulation shield concurrently through a single-pass process or dual tandem extrusion of the strand shield and the insulation/insulation shield that is applied in a common extrusion head which does not expose the EPR insulation to the atmosphere. The manufacturer shall utilize in-house compounding of the insulation and shielding material.

C. Insulation level to be as follows.

1. 15 KV, 220 mils, rated for 133% of nominal voltage.

2. 38 KV, 420 mils, rated for 133% of nominal voltage

2.6 SHIELD/NEUTRAL

A. Shield to be bare 5-mil minimum thick copper tape helically applied over the extruded insulation with 25% nominal overlap.

2.7 JACKET

A. Jacket to be flame-resistant, low-friction Polyvinyl Chloride (PVC).

B. Cable to be covered with an overall corrugated aluminum sheath or aluminum interlocked armor when called for on drawings to be armored cable.

2.8 CABLE RATINGS

A. Cable shall have the following ratings:

1. 105 degrees C continuous operating temperature.
2. 140 degrees C emergency rating.
3. 250 degrees C short circuit rating.
4. Flame retardant-passes.

B. Cable shall be rated for direct burial in accordance with the NEC.

C. Cable shall be Flame Retardant, Sunlight and Moisture-resistant for Cable Tray use in accordance with NEC Article 318.

D. Cable shall be rated for installation in direct sunlight.

2.9 CABLE CHARACTERISTICS

A. Cable to have the following characteristics:

1. Corona resistant.
2. Radiation resistant.
3. Clean stripping screens.
4. Moisture resistant.
5. Resistant to most oils, acids, and alkalies.

2.10 SPLICES

A. Splices shall be made with a tin-plated copper compression connector and a compression tool as approved by the manufacturer of the connector. Tool shall be of the hydraulic pump type or the type that crimps to the required size before releasing.

B. Electrical voltage stresses shall be controlled by utilization of high permitivity, high resistivity, heat shrinkable polymeric tubing.

C. The splice shall be sealed with a heat activated adhesive and an outer heat shrinkable jacket tubing. Splice shall provide continuity of the cable shield using a wire mesh and grounding clamps.

D. TEE splices are not allowed.

PART 3 - EXECUTION

3.1 DELIVERY AND STORAGE

A. All reels shall be shipped in the upright position. Any reels arriving in a “flopped” on the flange (side) position will be received and inspected subject to hidden damage and shall be noted on the bill-of-lading and signed by the freight carrier. The contractor or other person receiving the material shall be responsible for inspection for damages and contacting the supplier immediately upon receipt of any damaged material.

B. All cable shall be stored in an upright position.

C. Manufacturer shall seal the cable ends to prevent the entrance of moisture.

D. After the cutting of any lengths, the exposed ends of any remaining cable on the reel shall have heat-shrinkable end caps applied to prevent the entrance of water or vapor.

E. All cables shall be transported and handled in accordance with the manufacturer’s recommendations.

F. Cable should be stored under cover or, if not possible, covered by opaque plastic or canvas. Reels under the covering should have adequate ventilation to prevent the formation of condensation.

3.2 INSTALLATION

A. General:

1. The installer shall assume responsibility for exercising care and good judgment in the transportation, handling, installation, splicing, terminating and testing of the cable using acceptable industry practice and testing standards. Cable pulling stress calculations shall be performed to assure that all circuits are installed in strict accordance with the physical limits of the cables as stated by the manufacturer.
2. Deliver all conductors to job site new and in original wrapping, package or reel.
3. The installer shall provide the engineering firm of this project and the end user satisfactory written documentation and references as to their experience in splicing and terminating medium-voltage power cable.
4. Ground terminations with #6 copper insulated to 600 volts as detailed on the drawings.

5. Use UL listed and cable manufacturer pulling compound to pull conductors. Grease is not acceptable.
6. Include 600-volt insulated ground as shown and sized on the drawings.
7. Terminate all cables as specified in Section Medium Voltage Cable Splices and Terminations 26 05 14.
8. All conductors and connections shall test free of grounds, shorts, and opens.
9. Label all circuits with imprinted labels. Stick-on labels are not allowed. Labels shall be installed at all manholes and termination cabinets.

3.3 CABLE PLACEMENT

A. Cable shall be carefully checked and tested to verify the electrical condition, size, and length before being pulled into raceways. Cable pulled into the incorrect raceway or cut too short to rack, train, or splice as specified herein shall be removed and replaced by and at the expense of the Contractor.

1. Cable in Manholes: Cable shall be supported at all times during handling. Cable ends shall be sealed to prevent the entry of moisture or dirt. Cable racks or trays shall be provided for permanent support. Temporary support required during placement shall be with rope slings, timbers, or alternate method acceptable to the Engineer.
2. Supports: Cable supports and securing devices shall have bearing surfaces oriented parallel to the surfaces of the cable sheath and shall be installed to provide adequate support without deformation of the cable jackets or insulation. Adequate cable end lengths shall be provided and properly placed in electrical equipment or manholes to avoid longitudinal strains and distorting pressures on the cable at termination points and duct end bells. Final inspection shall be made after all cable is in place. Where supports, bushings, and end bells deform the cable jacket, additional supports shall be provided as directed by the Engineer.
3. Cable Racks: Cable racks shall be furnished and installed as required to provide the proper cable support. Cable racks shall be installed and spaced 36 inches apart and bolted to permanent wall surfaces with anchors or continuous slot concrete inserts.

3.4 MOISTURE SEALS

A. Cable ends shall be kept sealed except when termination and splicing work is being performed. Seal with heat-shrinkable caps with the sizes recommended by the cap manufacturer for the cable outside diameter and insulation. Caps shall contain sufficient adhesive that shrinkage of the cap during application results in formation of a positive, watertight seal. Heat-shrinkable caps shall be “Thermofit” as manufactured by Raychem Corporation or equal.

B. Before and after pulling, the leading end seal of each length of cable shall be examined and replaced if necessary. All cut cable ends shall be promptly sealed after cutting except those to be spliced or terminated immediately.

3.5 SPLICES

A. Power cable circuits may be spliced only at locations where specified or acceptable to the Engineer. Splices shall not be made to utilize short lengths of cable, nor shall they be made to provide correct lengths on cable initially cut too short for a circuit.

B. All underground splices will be within manholes and require written approval by Engineer of Record.

3.6 HIGH VOLTAGE TESTING

A. Each conductor of each run shall be tested for insulation integrity prior to energizing. The tested conductor shall include all splices, terminations, and the overall length of conductor, but SHALL NOT include switchgear, transformers, lightning arresters, or equipment. The test shall be a Very-Low Frequency (VLF) AC Sinusoidal Monitored Withstand Test (0.1 Hz). The cable shall be tested in accordance to the manufacturer's recommendations.

1. Testing Procedure: Perform VLF withstand test, tan delta, tip up, and stability tests with a purpose-built VLF tester with overload and current limiting devices to protect against short circuit current.

   a. VLF Withstand test: Raise test voltage in 4 equal steps at 3-minute intervals. Max test voltage shall remain on for a minimum of 30 minutes Measure and record current readings at each step after current has stabilized. If insulation breakdown is indicated by a sudden increase in current, discontinue test. Reperform test and if subsequent breakdown is observed stop testing and notify the engineer of record.
   b. Calculate test voltage for four steps (0.5Uo, 1.0Uo, 1.5Uo, and 2.0Uo). Test each cable individually for 3 min each step. Record Tan delta at Uo, tan delta standard deviation at Uo, difference in tan delta between 1.5Uo and 0.5Uo.

2. Test Type: Perform VLF AC high voltage tests according to IEEE Standard 400.2 Table 5 Installation testing (0.1Hz). Test voltage values shall be derived from system voltage, cable size, and cable insulation thickness.
3. Cable Test Report: The currents resulting from the AC high potential testing shall be recorded and provided to the Engineer. Test results shall demonstrate that the leakage current decreases or remains constant after reaching the specified test voltage.
4. NETA Testing Agent will evaluate withstand, tan delta, tip up, and stability test data to determine a pass/fail.

END OF SECTION 26 05 13

SECTION 26 05 14 - MEDIUM VOLTAGE CABLE SPLICES AND TERMINATIONS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. All work specified in this section shall comply with the provisions of Section 26 01 00.

B. Provide a complete system of cable terminations for medium voltage power as indicated on the drawings.

C. Refer to drawings for sizes of conductors.

D. This section governs the installation of cable stress cones, load break elbows, dead front "T's", and Electra.

PART 2 - PRODUCTS

2.1 STRESS CONES

A. Live front stress cones shall be 3M-7600 Series termination (cold shrink type) with grounding kits. Rated 5 KV or 15 KV as required. Raychem Heat Shrink type of equal rating is also acceptable.

2.2 DEADFRONT ELBOWS AND CONNECTORS

A. Applicable Standards: The 200 Amp Loadbreak and Deadbreak elbow connectors and 630 Amp Deadbreak bolted tee connectors purchased under this specification shall comply with the following standards:

1. ANSI/IEEE Standard 386: Separable Insulated Connectors for Power Distribution Systems Above 600V.
2. IEEE Standard 592 (Included in the Standard Above): IEEE Standard for Exposed Semiconducting Shields on Premolded High Voltage Cable Joints and Separable Insulated Connectors.

B. *ANSI/IEEE 386 - 2006 is the proposed revision that includes new testing to ensure the current carrying capability of the 200-ampere load break separable connectors.

C. Service Conditions: Modular insulated connectors shall be suitable for use under the following service conditions:

1. In air, including exposure to direct sunlight.
2. Intermittently or continuously submerged in water.
3. Environmental temperature between -20 degrees C to 65 degrees C.

D. Ratings:

1. Phase to phase voltage = 14.4 KV.
2. Phase to Ground = 8.3 KV.
3. B1L = 95 KV.
4. Current = 200 Amp or 600 Amp as required.

E. Manufacturers:

1. 200 Amp LB Elbow Connector, 15 KV - 36 KV: Cooper LE series, with capacitive test port, or equal.
2. 200 Amp and 400 Amp DB Elbow Connector, 15 KV - 36 KV: Cooper DE series, with capacitive test port, or equal.
3. 630 Amp DB Bolted Tee Connector, 24 KV - 36 KV: Cooper DT series, with capacitive test port, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in strict compliance with manufacturer requirements and industry standard.

B. Ground units as shown on the drawings.

C. Exercise care to keep units clean and install with neat workmanship.

D. Test units with cable as set forth in the cable sections.

END OF SECTION 26 05 14

SECTION 26 05 19 - CONDUCTORS 600 VOLT AND BELOW

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide a complete system of conductors for lighting, power, and controls throughout building.

B. Refer to drawings for sizes of conductors.

PART 2 - PRODUCTS

2.1 CONDUCTORS - POWER AND LIGHTING

A. Provide 98% conductivity copper conductors with 600-volt insulation.

B. Interior conductors shall be Type THHN-2/THWN-2 insulation.

C. 600-volt insulation for conductors installed in underground raceways shall have XLP (cross-linked polyethylene) insulation, Type XHHW-2.

D. For feeder and branch circuit conductors No. 12 AWG and No. 10 AWG, provide solid type.

E. For all control and motor circuits, and all conductors No. 8 AWG and larger, provide stranded type.

F. Conductors shall be manufactured by Triangle, Phelps Dodge, Southwire, or approved substitute.

G. Provide white or gray colored neutral conductors; provide black or color coded phase conductors.

H. Provide No. 14 AWG stranded type THHN fixture conductors, for conductors entering fixtures and in stems of pendant fixtures.

I. Provide type THHN stranded conductors, 90° C for conductors running through continuous rows of fluorescent fixtures.

J. For service entrance conductors and panel feeders (#1/0 and larger), stranded aluminum conductors of equivalent ampacities may be substituted. Increase conduit sizes to accommodate larger aluminum conductors. (Aluminum conductors are not acceptable for HVAC or Motor loads.)

K. Where permitted by local codes, Type MC cable may be used for branch circuits routed concealed above ceilings or in walls.

2.2 CONDUCTORS - CONTROLS

A. Single Conductor

1. Class B stranded soft-drawn copper with 600 volt thermoplastic insulation.
2. Size 14 AWG.
3. Type THHN/THWN.

B. Multiconductor

1. 600 Volt insulated Type TC
2. 16 AWG stranded (7x24) copper
3. PVC insulation – unshielded
4. 90º C rating

2.3 CONDUCTORS - INSTRUMENTATION

A. Type TC, Class B concentrically stranded copper with 300 volt PVC insulation.

B. Single twisted pair of triad shielded cables as required.

C. Overall foil shield with stranded, tinned copper drain wire.

D. Separate communication wire for calibration.

E. Size 16 or 18 AWG.

F. Temperature Rating: 105°C.

2.4 CONDUCTORS - THERMOCOUPLE

A. Solid thermocouple extension wire with 300 volt PVC insulation (nominal 16 mils).

B. Color coded per ANSI - MC96.1 - 1982.

C. Single twisted pair, one conductor identified, with overall aluminum/mylar shield with a tinned copper drain wire.

D. PVC insulated copper communications wire.

E. Size 16 AWG for runs over 100 feet - otherwise 20 AWG.

F. Temperature Rating: 105° C.

2.5 DATA CONNECTIONS

A. Ethernet shall be CAT-6 manufacturer’s rated cable.

1. Industrial Ethernet cable with 300 volt PVC jacket
2. RJ-45 Compatible
3. Gigabit Ethernet, Ethernet I/P compliant
4. Temperature Rating: 75° C.

B. Ethernet Fiber Optic cable shall be multimode with the following features.

1. Fiber Type: OM3 50/125 (µm) Micron multimode.
2. 12 strand fiber unless specifically detailed on plans
3. Gigabit Ethernet compatible.TIA/EIA 455 certified for crush and impact resistance.
4. 300 volt PVC insulated.
5. Temperature Rating: 70° C.

C. Serial RS-485 cable shall be 22 gauge twisted, shielded pairs (2-pair).

1. 100% foil covered.
2. 65% braid.
3. 120 ohm characteristic impedance.
4. 11 pF/ft conductor to conductor and 20.9 pF/ft conductor & shield.
5. 300 volt, 60°C PVC jacket.

D. Allen-Bradley DH+ cable.

1. Twinax shielded cable.
2. Nominal characteristic impedance: 78 ohms
3. Nominal inductance: 0.13 µH/Ft
4. Nominal capacitance: 19.7 pF/Ft conductor to conductor.
5. Outer jacket: 300 volt PVC for dry installation and Polyethylene for wet applications.
6. Temperature Rating: 80° C.

E. ControlNet cable

1. RG-6/U Coax with 18 AWG solid copper conductor
2. Quad shielded with 100 % coverage
3. Nominal characteristic impedance: 75 ohms
4. Nominal inductance: 0.093 µH/Ft
5. Nominal capacitance: 16.3 pF/Ft conductor to shield.
6. Outer jacket: PVC for dry installation and PVDF for wet applications.
7. Temperature Rating: 75° C

F. ODVA DeviceNet (Thicknet) Cable

1. Multiconductor cable with stranded conductors.
2. 15 & 18 AWG tinned conductors for bus power and data.
3. 65% coverage braided shield
4. Impedance per pair: 120 ohms
5. Nominal capacitance: 12 pF/Ft (18 AWG pair)
6. 600 volt PVC outer jacket
7. Temperature Rating: 75° C.

G. ODVA DeviceNet (Thinnet) Cable

1. Multiconductor cable with stranded conductors.
2. 22& 24 AWG tinned conductors for bus power and data.
3. 65% coverage braided shield
4. Impedance per pair: 120 ohms
5. Nominal capacitance: 12 pF/Ft (18 AWG pair)
6. 600 volt PVC outer jacket
7. Temperature Rating: 75° C.
8. Rated for NEC Class II application.

H. Foundation Fieldbus or PROFIBUS Cable

1. 18 AWG stranded tinned copper twisted conductors
2. 100 % overall aluminum foil-polyester shield with drain wire
3. Inductance: 0.19 µH/Ft
4. Impendence: 100 ohms at 0.03125 MHz
5. Nominal Capacitance: 24 pF/Ft conductor to conductor
6. 300 volt PVC outer jacket
7. Temperature RATING: 105° C

2.6 ACCEPTABLE MANUFACTURERS AND TYPES - CONTROLS, INSTRUMENTATION, DATA CONNECTIONS AND THERMOCOUPLE

A. Use Belden or approved substitute.

B. Control Wiring: Belden 27090A multiconductor cable

C. Instrumentation: Twisted Pair – Belden 1032A or Belden 3076F cable.

D. Instrumentation: Twisted Triad – Belden 1031A cable.

E. Thermocouple Extension: Belden 311xA series cable where x = thermocouple type.

F. Ethernet Cable: Belden 7953A DataTuff Cat-6 shielded cable

G. Ethernet Fiber: Belden I100655 Fiber – TrayOptic fiber cable.

H. RS – 485 Cable: Belden 3107A cable

I. ControlNet Cable: Belden 3092A or 3093A for underground and wet locations

J. DH+ Cable: Belden 9463 or Belden 9463DB for underground locations

K. DeviceNet: Belden 9880 (Thicknet) or 9907 (Thinnet)

L. Foundation Fieldbus and PROFIBUS Cable: Belden 1327A (2 – Pair) for connection from control cabinet to segment protector and Belden 3076F (1 – Pair) for instrument drop connection.

2.7 TRAY CABLE

A. Description: Control or power cable for use in cable trays and raceways. THWN-2 insulated copper conductors for use in areas with ambient temperatures above 30° Fahrenheit. XHHW-2 insulated copper conductors for use in areas with ambient temperatures at or below 30° Fahrenheit.

B. Type TC Cable.

C. Meets UL 1581 for CT use.

D. Meets UL 1277 for direct burial and sunlight resistance.

E. Color coded per ICEA-S-58-679 Method 1 for control cable.

F. Color coded per ICEA-S-58-679 Method 4 for power cables.

G. Insulated voltage rating: 600V.

2.8 VARIABLE FREQUENCY DRIVE (VFD) CABLES

A. 1000-volt insulation, flexible motor supply cable.

B. 3/Conductor stranded copper with full size ground wire.

C. Tinned copper braid shield.

D. Full size with drain wire.

E. XLPE insulation.

F. PVC Jacket.

G. Rated for cable tray use where installed in cable tray.

NOTE TO DESIGNER: USE THE FOLLOWING ONLY AFTER APPROVAL FROM THE OWNER, PRIOR TO ISSUING CD'S

2.9 TYPE MC CABLE

A. Type MC Cable shall not be used without prior written approval from the Owner. If approval is given, MC Cable shall only be permitted as allowed by local code and as described below.

B. MC Cable serving patient care areas (patient rooms, exam rooms, therapy rooms, patient corridors, and support areas) must be provided with a redundant ground wire and be listed for health care use.

C. MC Cable is not permitted (under any circumstance) for use on Emergency Circuits – Life Safety Branch, Critical Branch, Equipment Branch.

D. Maximum length of MC Cable per branch circuit shall be limited to 35 feet after transition from EMT. MC Cable shall not be permitted directly inside a panelboard. EMT conduit shall be used from the panel.

E. MC Cable is permitted for emergency circuits when installed inside prefabricated headwalls or casework. Under these circumstances, the length of MC Cable for emergency circuits shall be limited to 6 feet.

F. MC Cable shall not be permitted for use in branch circuits serving HVAC, elevator/escalator, medical and kitchen equipment loads.

G. MC Cable shall not be permitted for use within mechanical, electrical, or telecommunications rooms.

H. MC Cable shall not be used for exposed branch circuits or wet locations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pull boxes in circuits or feeders over 100' long.

B. Make all splices or connections only at outlet, pull or junction boxes.

C. Use pulling compound to pull conductors.

D. Install instrument and data connection conductor in separate raceways from all other conductors. Separate control wiring from power wiring in separate raceways. Separation distances shall be as specified by control system manufacturer or as listed in IEEE Standard 518, whichever is greater.

E. Bend radius on conductors shall be less than the limitations listed by the cable manufacturer.

F. Deliver all conductors to job site new and in original wrapping, package or reel.

G. All conductors and connections shall test free of grounds, shorts, and opens.

H. For 20-amp, 120-volt branch circuits, provide No. 10 wire in lieu of No. 12 wire for any branch circuit in excess of 90 linear feet to prevent excessive voltage drop. Where branch circuit exceeds 175 linear feet, use No. 8 wire.

I. Use Ideal wing nuts, Scotchlok Type Y, R, G, or B, or approved equivalent connectors for fixture connections at outlet boxes.

J. Make feeder taps and joints with OZ type T, PT, PM or PTS, or approved equivalent clamp connectors as manufactured by Kupler, or with approved compression sleeves. Wrap connectors with No. 10 electro-seal or approved equivalent plastic filler and vinyl tape.

K. Use only compression lugs equal to T & B series 60,000 for termination of aluminum conductors.

L. Leave a minimum of 8" slack wire in every outlet box whether it be in use or left for future use.

M. Color code conductors as follows:

N.

CONDUCTOR COLOR CODE		
	120/208 Volt	277/480 Volt
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green

O. Use factory color coded conductors.

NOTE TO DESIGNER: USE THE FOLLOWING ONLY ON REMODEL & ADDITION PROJECTS.

P. If the above conflicts with existing color coding, match existing.

Q. Use factory color coded conductors where commercially available. If not, use black wire and band with color tape.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The entire system of raceways and equipment to be grounded in accordance with Article No. 250 of latest edition of National Electrical Code and any local regulation or governmental governing authority.

PART 2 - PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

A. Main service switchboard shall be bonded to street side of first flange or coupling of incoming main water line serving project with heavy-duty ground clamp in accordance with Article 250.104 of N.E.C. The grounding electrode conductor shall be sized in accordance with Table 250.66 of N.E.C. An additional ground wire of same size shall be run to a tripod grounding rod system driven in ground outside foundation of building. This system shall consist of three 3/4" x 10' copperweld ground rods driven in ground in an equilateral triangular configuration with a minimum of 15' spacing between each. Connection of each ground rod to one another shall be made using a conductor of same size as being run for main service ground. Building steel shall be connected to ground bus on main service with a conductor the same as required on the service. This ground will be in addition to the previously specified grounds.

2.2 GROUND CLAMPS

A. OZ Electrical Manufacturing Company, Steel City, Appleton, or approved substitute.

B. Feeder circuits to panels, motor control centers, etc., shall have a separate green grounding conductor in conduit sized in accordance with Table 250.122 of N.E.C.

C. All branch circuits shall have a separate green grounding conductor installed in same conduit as phase and neutral conductor from panel ground bus to device. The grounding conductor shall be sized in accordance with Table 250.122 of N.E.C.

D. Ground all electrically operated shop equipment utilizing separate code size grounding conductors run in feeder conduits or contained within outer jacket enclosing the circuit conductors contained in flexible cords.

E. Flexible conduit will not be approved as achieving continuity of ground. All flexible conduit shall have a jumper wire sized to ampacity of branch breaker and

shall be connected to conduit system on both ends; this applies to fixtures, motors, controls, etc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Effectively bond all grounding conductors to grounding electrodes, equipment enclosures and ground busses.

B. Provide a shunt path around main water meter by bonding around both sides of meter to assure continuity.

C. Locate all grounding attachments away from areas subject to physical damage. Provide protective covering as required.

D. Clean all non-conductive surfaces on equipment to be grounded, to assure good electrical continuity.

E. Ground on main service shall be tested to obtain no greater than 10 ohms using 3-Point Fall of potential test. Test data shall be submitted to Engineer for review and such test data shall become a part of the final brochure.

END OF SECTION 26 05 26

SECTION 26 05 29 - SUPPORTING DEVICES AND HANGERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide a system of supporting devices and hangers to ensure secure support or bracing for conduit, electrical equipment, including safety switches, fixtures, panelboards, outlet boxes, junction boxes, cabinets, etc.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Provide appropriate supporting devices and hangers as manufactured by Erico Products, Inc., Steel City, Rayco, or approved substitute:

1. Vertical flange clamps (beam clamps).
2. "Z" purlin clips.
3. Conduit clips.
4. Universal clamps (Beam clamps).
5. Beam clamps (set screw type).
6. Combination push-in conduit clips.
7. Combination conduit hanger clamps.
8. Flexible conduit clips.
9. Special combination conduit clips.
10. One hole steel straps.
11. Minerallac conduit hangers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Secure conduits to within 3' of each outlet box, junction box, cabinet, fitting, etc., and at intervals not to exceed ten feet (10') for EMT and IMC conduit and in accordance with Table 344.30 (B) (2) for Rigid Steel conduit.

B. Install clamps secured to structure for feeder and other conduits routed against the structure. Use drop rods and hangers or racks to support conduits run apart from the structure.

C. Furnish and install suitable angle iron, channel iron or steel metal framing with accessories to support or brace electrical equipment including safety switches, fixtures, panelboards, outlet boxes, etc.

D. Paint all supporting metal not otherwise protected, with rust inhibiting primer and then with a finish coat if appropriate to match the surrounding metal surfaces. (Prepainted or galvanized support material is not required to be painted or repainted.).

E. Use of chains, perforated iron, bailing wire, or tie wire for supporting conduit runs will not be permitted.

F. For support of low voltage wiring not required to be in conduit, Contractor shall bundle cables together in a neat manner using approved nylon tie wraps. Bundled cables shall be supported with "J" hooks on telephone type bridle rings, a minimum of 6 feet on centers. Contractor shall clearly identify all differing types of cables being run and tag them with tape tags reading **"**telephone**",** **“**data**”,** etc**.,** for the appropriate system cables. Identification tape shall be provided at minimum intervals of 25 feet on center and within each building space.

END OF SECTION 26 05 29

SECTION 26 05 34 - RACEWAYS AND CONDUIT SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide a complete conduit system with associated couplings, connectors, and fittings.

B. Conduits shall be mechanically and electrically continuous from outlet to outlet and from outlets to cabinets, pull or junction boxes.

1.2 SUBMITTALS

A. Submittal for products furnished under this section is not required.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. IMC, RGS and EMT conduit shall be hot-dip galvanized, or electrogalvanized steel by Allied, Wheatland Tube, Republic Conduit, Western Tube, or approved substitute.

B. Erickson couplings for IMC and RGS, shall be used where neither length of conduit can be rotated.

C. IMC/RGS conduit connectors from 3/4” to 4” trade sizes shall use compression type.

D. EMT conduit connectors from 3/4” to 2” trade sizes shall use set screw type.

E. Weatherproof hub shall be complete with sealing "O" ring or sealing locknuts.

F. Provide polyvinyl chloride (PVC) conduit, Type 40, and associated couplings, connectors, and fittings. PVC conduit shall be UL listed and 90 degrees C UL rated.

G. Provide aluminum conduit in areas requiring non-ferrous materials.

2.2 ELECTRICAL METALLIC TUBING (EMT)

A. Use Electric Metallic Tubing (EMT) for:

1. Branch circuits installed overhead, both exposed and concealed, installed more than 6 feet above finished floor.

2. Branch circuits originating from isolated panels (O.R., Cystoscopy, or Delivery).

2.3 INTERMEDIATE METAL CONDUIT (IMC)

A. Use Intermediate Metal Conduit (IMC) for:

1. Branch circuits installed in hazardous areas.
2. Branch circuits and feeders installed in concrete slabs at ground floor.
3. Branch circuits installed exposed below 6 feet above finished floor.
4. Branch circuits installed in wet locations.
5. Pendant drops.

2.4 RIGID GALVANIZED STEEL (RGS)

A. Conduit Use:

1. Interior and exterior exposed primary service conduit.
2. Interior and exterior exposed secondary service conduit.
3. Exterior exposed branch circuits.

2.5 POLYVINYL CHLORIDE (PVC)

A. Use PVC for:

1. Service entrance conduits for power encased in concrete.
2. Service entrance conduits for telephone.
3. Exterior feeders encased in concrete.
4. Exterior underground branch circuits.

B. PVC conduit shall not be used for feeders or branch circuits inside the building.

2.6 FLEXIBLE METAL CONDUIT

A. Provide a flexible metal conduit system for the termination points at equipment that may possibly vibrate such as motors, welders, etc. The length shall not exceed 6 feet.

B. Conduit shall be electrically continuous from outlet or conduit end to the utilization equipment.

C. The total length of flexible conduit in any circuit shall not exceed 6 feet.

D. Where exposed to continuous or intermittent moisture, conduit shall be liquid tight flexible type, U.L. Type EF.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Minimum size of conduits shall be 3/4 inch.

B. Conduit joints shall be cut square, threaded, reamed smooth, and drawn up tight so conduit ends will butt in couplings, connectors, and fittings.

C. Make bends or offsets with standard ells or field bends with an approved bender.

D. Run conduits concealed in floor slabs, below slabs, or in walls in direct line with long sweep bends or offsets. Run exposed conduits and conduits run above lay-in ceilings parallel to and at right angles to building lines. Group multiple conduit runs in banks.

E. Secure EMT conduits to all boxes and cabinets with a steel set screw on the outside and a locknut on the inside.

F. Cap ends of conduits to prevent entrance of water and other foreign material during construction.

G. Complete conduit systems before pulling conductors.

H. Provide cable supports in conduits rising vertically in accordance with the National Electrical Code, Article 300-19.

I. Provide nylon pull cord in all empty conduits. Steel wire not acceptable as pull wire.

J. Conduits which pass through floor slabs (except ground floor) shall be sealed with concrete grout. Seal around conduits or other wiring materials passing through partitions, which extend to the underside of the slab above, and those passing through smoke partitions and fire-rated walls. Refer to appropriate details on architectural and mechanical drawings.

K. Conduits which enter crawl space, tunnels, and basements from outside the building shall be grouted-in to prevent entry of gases, vapors, insects, or rodents to these spaces from street mains.

L. Conduit not serving elevator equipment shall not be permitted to pass through elevator shafts or elevator equipment rooms.

M. Where IMC or RGS conduit is installed in a cabinet, junction box, pull box, or auxiliary gutter, conductors shall be protected by an insulated bushing. Locknuts shall be installed on conduit outside and inside enclosure.

N. In areas where enclosed and gasketed fixtures and weatherproof devices are specified, where rigid conduit enters a sheet metal enclosure, junction box and outlet box, and not terminated in a threaded hub, a steel, or malleable iron nylon

insulated hub, complete with recessed sealing "O" ring or sealing locknut shall be used.

O. Where conduits stub up in conduit space beneath switchgear and do not connect directly to equipment enclosures, use malleable iron nylon insulated ground bushing with a lay-in lug design complete with bonding screw, Raco 1212-1296.

P. Provide seal-off fitting in all conduits entering hazardous areas and any conduits entering a cold temperature area such as freezers and dry refrigerators.

Q. In concrete slabs, block up conduit from forms and securely fasten in place. All conduits in slabs shall have a minimum of 1-1/2 inches concrete coverage above and below.

R. Encase in 4 inches of 1:2:4 mix concrete on all sides all feeder conduits laid below ground outside building foundation line.

S. Where conduits running overhead pass through building expansion joints they shall be connected by flexible metal conduit of same size with sufficient slack to allow conduits on either side of expansion joint to move a minimum of 3 inches in any direction. Provide supports as required on each side of expansion joint, all in accordance with seismic requirements of specific area.

T. Conduits for feeders and branch circuits shall be terminated directly into panelboard enclosure without the use of pull boxes, junction boxes, wireways, or auxiliary gutters, unless the panelboard enclosure does not provide sufficient surface area for all conduits. Where such cases exist, the contractor shall notify the Designer. In no case will splices in such boxes, wireways, etc., be permitted.

U. Failure to route conduit through building without interfering with other equipment and construction shall not constitute a reason for an extra charge. Equipment, conduit, and fixtures shall fit into available spaces in building and shall not be introduced into building at such times and manner as to cause damage to structure. Equipment requiring servicing shall be readily accessible.

V. No conduit shall be installed in elevated slabs.

3.2 EMT

A. Do not use electric metallic tubing in cinder concrete or cinder fill where subject to permanent moisture unless protected on all sides by a layer of noncinder concrete at least 2 inches thick or unless the EMT is at least 18 inches under the fill. Use of set-screw fitting is not acceptable in concrete or in fill under slab.

3.3 PVC

A. Use threaded fittings for all connectors and adapters.

B. Provide code sized ground conductors in all power conduit runs.

C. Provide 1/4-inch nylon pull rope in all primary power and incoming telephone service entrance conduits.

D. Encase all PVC conduit in reinforced concrete with a minimum of 4-inch encasement on all sides except exterior branch circuits.

E. No PVC shall emerge from the ground or the concrete slab or encasement. PVC shall convert to galvanized rigid metal prior to its emergence.

F. Make bends with standard ells or with an approved heat bender.

3.4 FLEXIBLE METAL CONDUIT

A. Flexible metal conduits shall be 1/2 inch minimum size.

B. Where fittings for liquidtight flexible conduit are brought into an enclosure with a knock-out, a gasket assembly, consisting of one piece "O" ring, with Buna-N sealing material, Raco Series 3500, shall be installed on outside of box. Fittings shall be made of either steel or malleable iron only, and shall have insulated throats or insulated bushings.

C. In dry locations, where final connections to motors and other equipment may be made with flexible metal conduit, fittings shall be of steel or malleable iron only with insulated throats or insulated bushings, and shall be of wedge and screw type having an angular wedge fitting between convolutions of conduit.

D. An additional copper ground wire shall be installed inside of flexible conduit and bonded at each end to assure continuity of ground to lighting fixtures, controls, and other utilization equipment.

E. All recessed lighting fixtures shall be connected with flexible metallic conduit from outlet box to fixture. Rigid conduit connections to lighting fixtures are not acceptable.

F. Install liquidtight flexible conduit in such a manner as to prevent liquids from running on the surface toward fittings.

G. Allow sufficient slack conduit to reduce the effect of vibration.

END OF SECTION 26 05 34

SECTION 26 05 36 – CABLE TRAYS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. All work in this section shall comply with the provisions of Section 26 01 00 (General Provisions for Electrical Systems).

B. Furnish and install a complete cable tray system. System shall include all straight trays, fittings, and related support/accessory items as required for a complete installation.

C. Use:

1. Exposed six feet minimum above finished grade.
2. Where shown on the plan sheets.

D. Cable tray shall not be used where exposed to physical damage.

E. Standards:

1. The cable tray shall conform to NEMA Standard VE-1. The tray installation shall be in conformance with the National Electric Code.
2. If used as an equipment grounding conductor, the tray shall be as classified by Underwriters Laboratories and rated in accordance with NEC Table 318-10.

1.2 REFERENCES

A. NEMA VE 1 – Metal Cable Tray Systems (Latest Edition)

B. NEMA VE 2 – Cable Tray Installation Guidelines (Latest Edition)

C. ANSI/NFPA 70 National Electrical Code (Latest Edition)

PART 2 - PRODUCTS

2.1 RACEWAY TYPE

A. Tray Type:

1. Trays shall be of the ladder type as indicated on the drawings.
2. Ladder Type Tray:

a. Shall have required rung spacing to ensure adequate cable bearing surface for the installed conductors.

b. Rungs shall be of the double rung or box type and shall be free of sharp edges or corners.
c. Rungs shall be capable of supporting a 200 lb. concentrated load (applied to the middle six inches of width) without permanent deformation.

2.2 MATERIALS/FINISH

A. Straight section, fitting side rails, rungs and splice plates shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.

2.3 STRENGTH

A. The power and control cable tray shall be capable of carrying a uniformly distributed cable load of 100lbs per foot when supported on 20 ft. spans and shall be rated as a NEMA Class 20C.

2.4 DIMENSIONS

A. Cable tray shall be 6 inches in overall height with an interior cable loading depth of 5-3/8 inches. Widths shall be as identified on project drawings.

PART 3 - EXECUTION

3.1 CONSTRUCTION

A. Tray shall be of all-welded construction and utilize "C" shaped channel siderails with flanges facing inward.

3.2 SUPPORTS

A. Installer shall supply all clamps, clips and associated parts for a complete support system.

3.3 FIRE BARRIER SEALS

A. Where cable trays penetrate through fire rated walls, they shall be sealed either with a fire barrier composite sheet or a fire barrier pillow.

3.4 GROUND WIRE

A. A #4/0 bare copper raceway ground wire shall be bonded to cable tray sections or transitions section by grounding clamp and bonded at each and any discontinuous section of tray. Conductor is not required to be continuously installed along tray, only at jumps in system that are not bonded together with listed bolted fittings to be electrically continuous.

3.5 FITTINGS

A. All elbows, tees and cross fittings shall be supplied without straight tangents beyond the point of curvature. Fittings shall be supplied in 36-inch radius.

3.6 ACCESSORIES

A. Cable tray system shall include all related accessory items such as dropouts, end plates and barrier strips to separate services in the trays. Covers shall be furnished as required for cable protection (e.g., for vertical, riser trays as they penetrate floors, etc.).

3.7 INSTALLATION

A. Install cable trays as indicated: Installation shall be in accordance with equipment manufacturer's instruction, and with recognized industry practices to ensure that cable tray equipment comply with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines.

B. The straight sections of cable tray shall be furnished in 12-foot lengths. Shorter lengths shall be field-cut and spliced using the standard cable tray splice plate as a drilling jig (24-ft. lengths shall be used for long-span support applications).

C. Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2 guidelines, or in accordance with manufacturer's instructions.

D. Make bends or offsets with standard ells where possible.

E. Secure conduits to cable tray with double locknuts and grounding bushings so system will be electrically continuous.

F. Complete all conduit systems before installing conductors.

END OF SECTION 26 05 36

SECTION 26 05 38 - PULL AND JUNCTION BOXES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide pull and junction boxes of appropriate size and depth or as indicated on the drawings and as specified hereinafter.

1.2 SUBMITTALS

A. Submittals of products furnished under this section are not required.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS/MATERIALS

A. Pull and junction boxes shall be by Hoffman or approved substitute.

B. For interior work, provide galvanized sheet metal boxes of code thickness with lapped and welded joints, 3/4 inch flanges, screw covers, etc.

C. For exterior work, provide galvanized sheet metal boxes of code thickness with lapped and welded joints, 3/4 inch flanges, bolted covers with full gaskets forming a completely water-tight assembly, equal to Hoffman, Concept Series.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide junction boxes as shown on drawings and otherwise where required, sized according to number of conductors in box or type of service to be provided. Minimum junction box size 4 inches square and 2-1/8 inches deep. Provide screw covers for junction boxes.

B. Use minimum 16 gauge steel for pull boxes and provide with screw cover.

C. Install boxes in conduit runs wherever necessary to avoid long runs or excessive bends. Do not exceed 100 foot runs, or three 90 degree bends, without pull boxes.

D. Rigidly secure boxes to walls or ceilings. Use of conduit as a support is not acceptable.

E. Install boxes in accessible locations. Size boxes in accordance with Articles No. 312 and No. 314 of the latest edition of the National Electrical Code.

F. Install boxes so that the covers will be accessible at all times.

G. Do not install pull or junction boxes for joint use of line voltage and signal or low voltage controls unless all conductors are insulated for the highest voltage being used in the same box. Emergency system and normal system circuits shall not be routed through a common pull or junction box.

END OF SECTION 26 05 38

SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH STUDY

PART 1 - GENERAL

1.1 SUMMARY

A. ICT shall generate overcurrent protection coordination settings and arc flash labels. Contractor shall be responsible for procurement and installation of arc flash labels once digital files are provided by ICT.

1.2 SCHEDULING

A. Contractor shall provide ICT with a full list of all necessary breakers, provided as part of job, information required to complete required studies.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 ADJUSTING

A. Perform field adjustments of protective devices and modifications to equipment to place equipment in final operating condition. Adjust settings in accordance short circuit and protective device coordination study.

3.2 ARC FLASH SIGN INSTALLATION

A. Implement the Arc Flash sign installation requirements for electrical equipment as specified in NEC Article 110.16 Flash Protection and NFPA 70E.

END OF SECTION 26 05 73

SECTION 26 08 05 - ACCEPTANCE TEST PROCEDURES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide acceptance testing as described hereafter. Tests will be performed on the specified equipment as described, test results recorded in the format specified, deficiencies corrected and equipment retested where required, and final reports provided to the designer for approval.

B. Substantial completion documentation will not be issued until all required test forms have been approved by the designer and the owner.

1.2 RELATED SECTIONS

A. 26 0519 - Conductors - 600 Volt and Below

B. 26 0513 - Medium Voltage Conductors - 5 kV Through 46 kV

C. 260514 - Medium Voltage Cable Splices and Termination

D. 26 2200 – Dry Type Transformers

E. 26 2413 – Circuit Breaker Distribution Switchboards

1.3 CODES AND STANDARDS

A. All testing covered by these specifications will comply with the following list of codes and standards.

1. NFPA-70 National Electrical Code.
2. C2-1997 National Electric Safety Code.
3. ANSI/NETA ATS-2021 International Electrical Testing Assoc. Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

B. Where tests are required prior to energizing the Contractor shall not energize equipment until the Engineer has approved the test data. Tests and certifications required before substantial completion are a necessary part of issuing that document.

C. All tests required by these documents will be supervised by INETA certified technicians.

PART 2 - PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

A. Products are specified under the individual section specifying the individual equipment.

B. No materials are specified in this section.

PART 3 - EXECUTION

3.1 CONDUCTORS 600 VOLT AND BELOW

A. All new conductors 600 volts and below will be tested as follows.

B. Prior to energizing any circuit, the Contractor will loop check to verify that the circuit is connected to the proper piece of equipment. Each conductor will be checked with an Ohm meter to verify that no short circuit has been installed.

C. No special documentation is required. The Contractor will certify in writing prior to substantial completion that these tests have been performed.

3.2 CONTROL CONDUCTORS 120 VOLT AND BELOW

A. Control conductors are those installed specifically for the purpose of digital and analog communication between control equipment.

B. Prior to placing into service, the Contractor will loop check to verify that the circuit is connected to the proper piece of equipment. Each conductor will be checked with an Ohm meter to verify that no short circuit has been installed.

C. No special documentation is required. The Contractor will certify prior to substantial completion that these tests have been performed.

D. Functional checking of control conductors is included in the equipment specific section or in startup of specific equipment and is not included here.

3.3 CONDUCTORS 15 KV AND TERMINATIONS

A. Conductors 1000 volts and over will be tested in the following manner. Each individual conductor segment will be tested after the terminations are installed, prior to attachment to the equipment and prior to energizing. Testing of multiple segment lengths is not allowed. Multiple conductor cable will be tested single conductor at a time.

B. All medium voltage cables will be tested with results documented as specified in ANSI/NETA ATS-2021, Inspection and Test Procedure 7.3.3.

C. Testing will be performed under the supervision of an INETA/NICET certified technician.

D. INETA compliant Paperwork will be provided to the designer for approval prior to engineering equipment.

3.4 METAL-CLAD SWITCHGEAR

A. Prior to placing into service all metal-clad, medium voltage, switchgear will be tested as follows. All tests listed below are defined as the minimum specification required by ANSI/NETA ATS-2021. Test results shall be supplied to the Engineer prior to energizing.

1. Circuit Breakers will be tested with results documented specified in ANSI/NETA ATS-2021, Inspection and Test Procedure 7.6.3.
2. Instrumentation transformers, current and voltage, will be tested with results documented specified in ANSI/NETA ATS-2021, Inspection and Test Procedure 7.10.1 and 7.10.2.
3. Protective relaying will be tested with results documented specified in ANSI/NETA ATS-2021, Inspection and Test Procedure 7.9.2.
4. Metering will be tested with results documented specified in ANSI/NETA ATS-2021, Inspection and Test Procedure 7.11.2.

3.5 SWITCHGEAR AND SWITCHBOARD ASSEMBLIES

A. Visual and Mechanical Inspections:

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical, electrical, and mechanical condition of cords and connectors.
3. Inspect anchorage, alignment, grounding, and required area clearances.
4. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
5. Verify that fuse and circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker address for microprocessor-communication packages.
6. Verify that current and voltage transformer ratios correspond to drawings.
7. Verify that wiring connections are tight, and that wiring is secure to prevent damage during routine operation of moving parts.
8. Inspect bolted electrical connections for high resistance using one or more of the following methods:

    a. Use of a low-resistance ohmmeter in accordance with Section 3.5.B.1.
    b. Verify tightness of accessible bolted electrical connections by calibrated torque- wrench method in accordance with manufacturer’s published data or Table 100.12.
    c. Perform thermographic survey in accordance with ANSI/NETA ATS-2021 Section 9.

9. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

    a. Attempt closure on locked-open devices. Attempt to open locked - closed devices.
    b. Make key exchange with all devices included in the interlock scheme.

10. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
11. Inspect insulators for evidence of physical damage or contaminated surfaces.
12. Verify correct barrier and shutter installation and operation. Exercise all active components.
13. Inspect mechanical indicating devices for correct operation.
14. Verify that filters are in place and vents are clear.
15. Perform visual and mechanical inspection of instrument transformers in accordance with ANSI/NETA ATS-2021 Section 7.10.1 and 7.10.2.
16. Perform visual and mechanical inspection of surge arresters in accordance with ANSI/NETA ATS-2021 Section 7.19.1.
17. Inspect control power transformers.

    a. Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
    b. Verify that primary and secondary fuse or circuit breaker ratings match drawings.
    c. Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

B. Electrical Tests:

1. Perform resistance measurements through bolted electrical connections with a low - resistance ohmmeter in accordance with Section 3.5.A.8.1.
2. Perform insulation-resistance tests for one minute on each bus section, phase-to-phase and phase-to-ground. Apply voltage in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use ANSI/NETA ATS-2021 Table 100.1.
3. Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer’s published data. In the absence of manufacturer’s data, use ANSI/NETA ATS-2021 Table 100.2. The test voltage shall be applied for one minute. Refer to ANSI/NETA ATS-2021 Section 7.13 before performing tests.
4. Perform electrical tests on instrument transformers in accordance with ANSI/NETA ATS-2021 Section 7.10.1 and 7.10.2.
5. Perform ground-resistance tests in accordance with ANSI/NETA ATS-2021 Section 7.13.
6. Test metering devices in accordance with ANSI/NETA ATS-2021 Section 7.11.1 and 7.11.2.

7. Control Power Transformers:

    a. Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be in accordance with the manufacturer's published data. In the absence of manufacturer's data, use ANSI/NETA ATS-2021 Table 100.1.
    b. Perform a turns-ratio test on all tap positions.
    c. Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source.
    d. Verify correct potential at all devices.
    e. Verify correct secondary voltage by energizing the primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
    f. Verify correct function of control transfer relays located in the switchgear with multiple control power sources.

8. Voltage Transformers:

    a. Perform secondary wiring integrity test. Verify correct potential at all devices.
    b. Verify secondary voltages by energizing the primary winding with system voltage.

9. Perform current-injection tests on the entire current circuit in each section of switchboard / switchgear.

    a. Perform current tests by primary injection in accordance with ANSI/NETA ATS-2021 Section 7.6 magnitudes such that a minimum of 1.0 ampere flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

10. Perform system function tests in accordance with ANSI/NETA ECS Standard for Electrical Commissioning Specifications for Electrical Power Equipment and Systems.
11. Verify operation of cubicle switchgear/switchboard space heaters and their controller.
12. Perform phasing checks on double-ended or dual-source switchgear to insure correct bus phasing from each source.
13. Perform electrical tests of surge arresters in accordance with ANSI/NETA ATS-2021 Section 7.19.1.

C. Test Values – Visual and Mechanical:

1. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value. (3.5.A.8.1)
2. Bolt-torque levels shall be in accordance with the manufacturer's published data. In the absence of manufacturer's data, use ANSI/NETA ATS-2021 Table 100.12. (3.5.A.8.2)

3. Results of the thermographic survey shall be in accordance with ANSI/NETA ATS-2021 Section 9. (3.5.A.8.3).

D. Test Values – Electrical:

1. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2. Insulation-resistance values of bus insulation shall be in accordance with manufacturer's published data. In the absence of manufacturer's data, use Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated. Dielectric withstand voltage tests shall not proceed until insulation-resistance levels are raised above minimum values.
3. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
4. Minimum insulation resistance values of control wiring shall not be less than two megohms.
5. Results of electrical tests on instrument transformers shall be in accordance with ANSI/NETA ATS-2021 Section 7.10.1 and 7.10.2.
6. Results of ground resistance tests shall be in accordance with ANSI/NETA ATS-2021 Section 7.13.
7. Accuracy of metering devices shall be in accordance with ANSI/NETA ATS-2021 Section 7.11.

E. Control Power Transformers:

1. Insulation-resistance values of control power transformers shall be in accordance with manufacturer's published data. In the absence of manufacturer's data, use ANSI/NETA ATS-2021 Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated.
2. Turns-ratio test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio.
3. Secondary wiring shall be in accordance with design drawings and specifications. Secondary voltage shall be in accordance with design specifications.
4. Control transfer relays shall perform as designed.

F. Voltage Transformers:

1. Secondary wiring shall be in accordance with design drawings and specifications.
2. Secondary voltage shall be in accordance with design specifications.
3. Current-injection tests shall prove current wiring is in accordance with design specifications.
4. Results of system function tests shall be in accordance with ANSI/NETA ECS.
5. Heaters shall be operational.

6. Phasing checks shall prove the switchgear or switchboard phasing is correct and in accordance with the system design.
7. Results of electrical tests on surge arresters shall be in accordance with ANSI/NETA ATS-2021 Section 7.19.1.
8. Results of online partial-discharge survey should be in accordance with manufacturer's published data. In the absence of manufacturer's data, refer to ANSI/NETA ATS-2021 Table 100.23.

3.6 TRANSFORMERS – DRY-TYPE, AIR-COOLED, LOW VOLTAGE, SMALL

A. NOTE: This category consists of power transformers with windings rated 600 volts or less and sizes equal to or less than 167 kVA single-phase or 500 kVA three phase.

B. Visual and Mechanical Inspection:

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, and grounding.
4. Verify that resilient mounts are free and that any shipping brackets have been removed.
5. Verify the unit is clean.
6. Inspect bolted electrical connections for high resistance using one or more of the following methods:

    a. Use of a low-resistance ohmmeter in accordance with ANSI/NETA ATS-2021 Section 3.6.B.1.
    b. Verify tightness of accessible bolted electrical connections by calibrated torque- wrench method in accordance with manufacturer's published data or ANSI/NETA ATS-2021 Table 100.12.
    c. Perform thermographic survey in accordance with ANSI/NETA ATS-2021 Section 9.
    d. Verify that as-left tap connections are as specified.
    e. The Contractor will certify that this has been completed prior to substantial completion.

3.7 TRANSFORMERS – DRY-TYPE, AIR-COOLED, LOW VOLTAGE, LARGE

A. NOTE: This category consists of power transformers with windings rated higher than 600 volts and low-voltage transformers larger than 167 kVA single-phase or 500 kVA three-phase.

B. Visual and Mechanical Inspection:

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, and grounding.
4. Verify that resilient mounts are free and that any shipping brackets have been removed.

5. Verify the unit is clean.
6. Verify that control and alarm settings on temperature indicators are as specified.
7. Verify that cooling fans operate and that fan motors have correct overcurrent protection.
8. Inspect bolted electrical connections for high resistance using one or more of the following methods:

    a. Use of a low-resistance ohmmeter in accordance with Section 3.7.B.1.
    b. Verify tightness of accessible bolted electrical connections by calibrated torque- wrench method in accordance with manufacturer's published data or ANSI/NETA ATS-2021 Table 100.12.
    c. Perform thermographic survey in accordance with ANSI/NETA ATS-2021 Section 9.

9. Perform specific inspections and mechanical tests as recommended by the manufacturer.
10. Verify that as-left tap connections are as specified.
11. Verify the presence of surge arresters.

C. Electrical Tests:

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter in accordance with Section 3.7.A.8.1. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with the manufacturer's published data. In the absence of the manufacturer's data use Table 100.5 Calculate dielectric absorption ration and polarization index.
2. Perform power-factor or dissipation-factor tests on all windings in accordance with the test equipment manufacturer's published data.
3. Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.
4. Perform turns-ratio tests at all tap positions.
5. Perform an excitation-current test on each phase.
6. Measure the resistance of each winding at each tap connection. Test current not to exceed 10% of rated current.
7. Measure core insulation resistance at 500 volts dc if the core is insulated and the core ground strap is removable.
8. Perform an applied voltage test on all high- and low-voltage windings-to-ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
9. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
10. Test surge arresters in accordance with ANSI/NETA ATS-2021 Section 7.19.2.
11. Perform online partial-discharge survey on windings rated higher than 1000 volts in accordance with Section 11.

D. Test Values – Visual and Mechanical:

1. Control and alarm settings on temperature indicators shall operate within manufacturer's recommendations for specified settings. (3.7.A.6)
2. Cooling fans shall operate. (3.7.A.7)
3. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value. (3.7.A.8.1)
4. Bolt-torque levels shall be in accordance with the manufacturer's published data. In the absence of manufacturer's data, use ANSI/NETA ATS-2021 Table 100.12.1 (3.7.A.8.2)
5. Results of the thermographic survey shall be in accordance with ANSI/NETA ATS-2021 Section 9. (3.7.A.8.3)
6. Tap connections shall be left as found unless otherwise specified. (3.7.A.10)

3.8 PANELBOARDS

A. Prior to placing panel boards, the contractor will visually inspect all power bus and breaker connections.

B. Check each with connection with the appropriate size torque wrench.

C. With the panelboard operating at normal load perform a thermographic survey as required by the minimum standards specified in ANSI/NETA ATS-2021, Inspection and Test Procedure 9. Correct deficiencies detected. Document in writing that the equipment has passed the inspection. Include thermographic image for each equipment piece.

3.9 PROTECTIVE RELAYS

A. Visual and Mechanical Inspection:

1. Inspect relays for physical damage.
2. Inspect cover gasket, cover glass, cover condition.
3. Inspect for presence of foreign material or moisture.
4. Check mechanically for freedom of movement, proper travel and alignment, and tightness of mounting hardware and tap plugs.
5. Verify that all settings are in accordance with coordination study or Owner/User's provided settings.

B. Electrical Tests:

1. Perform the following tests on the nominal settings specified by the Owner/User's Electrical Engineer:

   a. Pick up parameters on each operating element.
   b. Timing tests at two (2) or more points on time-curve.
   c. Pick-up target and seal-in units.

d. Special tests as required to check operation of restraint, directional and other elements per manufacturer's instruction manual.

2. Conduct tests to verify satisfactory performance of each control feature.
3. Electrically confirm that CT and VT secondary circuits are intact.

C. Test Values: Refer to manufacturers' instruction manual for acceptable tolerances.

3.10 ADJUSTABLE SPEED DRIVE SYSTEMS

A. Visual and Mechanical Inspection:

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, and grounding.
4. Verify the unit is clean.
5. Ensure vent path openings are free from debris and that heat transfer surfaces are not contaminated by oil, dust, and dirt.
6. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
7. Motor running protection:

   a. Compare drive overcurrent setpoints with motor full-load current rating to verify correct settings.
   b. If drive is used to operate multiple motors, compare individual overload element ratings with motor full-load current ratings.
   c. Apply minimum and maximum speed setpoints. Confirm setpoints are within limitations of the load coupled to the motor.

8. Inspect bolted electrical connections for high resistance using one or more of the following methods:

   a. Use of low-resistance ohmmeter in accordance with Section 3.13 B.1.
   b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or ANSI/NETA ATS-2021, Table 100.12.
   c. Perform thermographic survey in accordance with ANSI/NETA ATS-2021, Section 9.

9. Verify correct fuse sizing in accordance with manufacturer's published data.

B. Electrical Tests

1. Perform resistance measurements through bolted connections with low-resistance ohmmeter in accordance with Section 3.13.A.8.a.
2. Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.

3. Test input circuit breaker by primary injection in accordance with ANSI/NETA ATS-2021, Section 7.6.
4. Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential shall be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration shall be one minute. For units with solid-state components, follow manufacturer's recommendation.
5. Test for the following parameters in accordance with relay calibration procedures outline in Section 3.11 or as recommended by the manufacturer:

    a. Input phase loss protection
    b. Input overvoltage protection
    c. Output phase rotation
    d. Over temperature protection
    e. DC overvoltage protection
    f. Over frequency protection
    g. Drive overload protection
    h. Fault Alarm outputs

6. Perform continuity tests on bonding conductors in accordance with ANSI/NETA ATS-2021, Section 7.13.
7. Perform startup of drive in accordance with manufacturer's published data. Calibrate drive to the system's minimum and maximum speed control signals.
8. Perform operational tests by initiating control devices.

    a. Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual noise or vibration.
    b. Verify operation of drive from remote start/stop and speed control signals.

9. Measure fuse resistance.

3.11 EMERGENCY SYSTEMS, UNITERRUPTIBLE POWER SYSTEMS

A. There are many configurations of uninterruptible power supply installations. It is the intent of these specifications to list possible tests of the major components of the system and more specifically the system as a whole. It is important that the manufacturer's recommended commissioning tests be performed.

B. Visual and Mechanical Inspection:

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Inspect anchorage alignment, grounding, and required clearances.
4. Verify that fuse sizes and types correspond to drawings.
5. Verify the unit is clean.
6. Test all electrical and mechanical interlock systems for correct operation and sequencing.

7. Inspect bolted electrical connections for high resistance using one or more of the following methods:

    a. Use of low-resistance ohmmeter in accordance with Section 3.14.C.1.
    b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or ANSI/NETA ATS-2021, Table 100.12.
    c. Perform thermographic survey in accordance with ANSI/NETA ATS-2021, Section 9.

8. Verify operation of forced ventilation.
9. Verify that filters are in place and / or vents are clear.

C. Electrical Tests:

1. Perform resistance measurements through bolted connections with a low-resistance ohmmeter in accordance with Section 3.14.B.7.a.
2. Test static transfer from inverter to bypass and back. Use normal load, if possible.
3. Set free running frequency of oscillator.
4. Test dc undervoltage trip level on inverter input breaker. Set according to manufacturer's published data.
5. Test alarm circuits.
6. Verify synchronizing indicators for static switch and bypass switches.
7. Perform electrical test for UPS system breakers in accordance with ANSI/NETA ATS-202, Section 7.6.
8. Perform electrical test for UPS system automatic transfer switches in accordance with Section 7.22.3.
9. Perform electrical tests for UPS system batteries in accordance with ANSI/NETA ATS-2021, Section 7.18.

D. Test Values, Visual and Mechanical:

1. Electrical and mechanical interlock systems shall operate in accordance with system design requirements. (3.14.B.6.)
2. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value. (3.14.B.7.a.)
3. Bolt-torque levels shall be in accordance with the manufacturer's published data. In the absence of manufacturer's published data, use ANSI/NETA ATS-2021 Table 100.12. (3.14.B.7.b.)
4. Results of the thermographic survey shall be in accordance with ANSI/NETA ATS-2021, Section 9. (3.14.B.7.c.)

E. Test Values, Electrical:

1. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2. Static transfer shall function in accordance with the manufacturer's published data.
3. Oscillator free running frequency shall be within manufacturer's published tolerances.
4. DC undervoltage shall trip inverter input breaker.
5. Alarm circuits shall operate in accordance with design requirements.
6. Synchronizing indicators shall operate in accordance with design requirements.
7. Breaker performance shall be in accordance with ANSI/NETA ATS-2021, Section 7.6.1.
8. Automatic transfer switch performance shall be in accordance with ANSI/NETA ATS-2021, Section 7.22.3.
9. Battery test results shall be in accordance with ANSI/NETA ATS-2021, Section 7.18.
10. Rotating machinery performance shall be in accordance with ANSI/NETA ATS-2021, Section 7.15.

3.12 FIBER-OPTIC CABLES

A. Visual and Mechanical Inspection:

1. Compare cable, connector, and splice data with drawings and specifications.
2. Inspect cable and connections for physical and mechanical damage.
3. Verify that all connectors and splices are correctly installed.

B. Optical Tests:

1. Perform cable length measurement, fiber fracture inspection, and construction defect inspection using an optical time domain reflectometer.
2. Perform connector and splice integrity test using an optical time domain reflectometer.
3. Perform cable attenuation loss measurement with an optical power loss test set.
4. Perform connector and splice attenuation loss measurement from both ends of the optical cable with an optical power loss test set.
5. Perform transmit and receive power measurements from local device and remote device.

C. Test Values, Visual and Mechanical:

1. Cable and connections shall not have been subjected to physical or mechanical damage. (3.15.A.1.)
2. Connectors and splices shall be installed in accordance with industry standards. (3.15.B.2.)

3.13 ENERGIZED TEST

A. The contractor will demonstrate that the installed system will function as designed. This test will be witnessed by the engineer or representative, the owner's representative and the contractor's representative. The contractor will provide electricians capable of making adjustments during the test as problems are identified. The contractor will record readings taken during the energized test and submit as a part of the final acceptance documents. Substantial completion will not be achieved until the system successfully completes this test.

B. Voltage Test:

1. The purpose for this test is to demonstrate that the loads are properly balanced after construction.
2. Duration of the test is 24 hours with maximum possible load added to each feeder.
3. At each programmable relay available set the following temporary alarms to record conditions that may occur. Upon completion of the test these temporary alarms are to be removed.
4. Required Voltage values:

    a. Phase balance (negative sequence) 1%.
    b. Phase under voltage, negative 5% of nominal.
    c. Phase over voltage, positive 5% of nominal.

C. At the end of the test, if the system does not perform as specified, perform appropriate corrective actions. Repeat the test after corrective action has been implemented.

D. During the test the contractor will perform thermographic survey in accordance with Section 9 of the ANSI/NETA ATS-2021 of the following systems.

1. All Medium voltage cable terminations in switchgear and transformers.
2. All low voltage power cables 250 KCM and larger that feed major equipment.
3. Medium voltage switchgear.
4. Low voltage switchgear.
5. Motor Control Centers

END OF SECTION 26 08 05

SECTION 26 1200 - PAD-MOUNTED TRANSFORMERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section includes distribution transformers with medium-voltage primaries. Types of transformers specified in this Section include liquid-filled, pad-mounted.

1.2 REFERENCES

A. The pad-mounted transformer(s) and all components shall be designed, manufactured and tested in accordance with the latest applicable NEMA (NEMA 210), IEEE and ANSI standards (ANSI C57).

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product data for each product specified, including dimensioned plans, sections, and elevations. Show minimum clearances and installed devices and features.

C. Wiring diagrams of transformers and accessory components, differentiating between manufacturer-installed and field-installed wiring.

D. Product certificates signed by manufacturers certifying that their products comply with the specified requirements.

E. Product Test Reports: Certified copies of manufacturers' design and routine factory tests required by the referenced standards.

F. Nameplate diagram with the following ratings:
1. kVA
2. Primary and Secondary Voltage
3. Taps
4. Basic Impulse Level
5. Impedance

G. Operation and maintenance data for materials and products to include in the "Operating and Maintenance Manual" specified in Division 01.

H. Field test reports of tests and inspections conducted according to Part 3 of this Section.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer of medium-voltage electrical distribution equipment to perform the installation specified in this Section. Refer to Division 01 Section "Reference Standards and Definitions" for definition of an experienced Installer.

B. Field Testing Agency Qualifications: To qualify for acceptance, the testing agency must demonstrate, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated.

C. Comply with NFPA 70 "National Electrical Code."

D. Comply with IEEE C2 "National Electrical Safety Code."

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. General Electric Company
2. ABB Power T & D Co., Inc.
3. Cooper.

2.2 TRANSFORMERS - RATINGS

A. Windings: Two-winding type, designed for operation with as indicated kV high-voltage windings connected to a 3-phase, 4-wire, 60-Hz, distribution system. Secondary windings to be as indicated.

B. Rating: as indicated KVA, 3 Phase, 60 Hz

C. Sound Level: Standard NEMA sound level.

D. Unusual Service Conditions: Provide transformers designed for the following conditions:

E. Windings: Copper.

F. Connection:
1. Primary: Delta
2. Secondary: Wye Grounded.

G. Impedance: 5.75 percent at rated kVA, +/- 7.50% manufacturing tolerance.

H. Insulation Temperature Rise: 55/65 degree C rise.

I. Basic Impulse Insulation Level:
   1. LV side: 30kV BIL
   2. 34.5kV Class Primary: 150kV BIL

2.3 TRANSFORMERS - GENERAL

A. Comply with IEEE C57.12.22 and C57.12.28 and with the following features and ratings.

B. Insulating Liquid: Insulating liquid shall be 10C mineral oil.

C. Full-Capacity Voltage Taps: Four nominal 2.5-percent taps, 2 above and 2 below rated high voltage, with externally operable tap changer for de-energized use, with position indicator.

D. High-Voltage Terminations and Equipment: The high voltage terminations and equipment shall be dead front and conform to ANSI C57.12.26.

E. High-Voltage Arrangement: Equipped for loop feed.

F. Fusing: Internal Bay-O-Net fuses in series with current limiting fuses. Size to protect transformer.

G. Surge Arresters: Provide MOV elbow arresters to comply with IEEE Standards 386 and C62.11.

H. Accessories: Provide the following accessories:
   1. One-inch (25-mm) drain valve with sampling device.
   2. Dial-type thermometer.
   3. Liquid level gauge.
   4. Pressure-vacuum gauge.
   5. Pressure-Relief Device: Self-sealing with indicator.
   6. Mounting provision for low-voltage current transformers and potential transformers.

2.4 FINISHES

A. Enclosure Coating System for Outdoor Units: Comply with IEEE Standard C57.12.28 "Pad-Mounted Equipment-Enclosure Integrity," regardless of transformer type.

2.5 SOURCE QUALITY CONTROL

A. Factory Tests: Design and routine tests conform to the referenced standards.

B. Factory Sound-Level Tests: Conduct sound level tests on equipment for this Project where specifying sound levels below the standard ratings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with IEEE Standard C2, "National Electrical Safety Code" and the manufacturer's written installation instructions.

B. Identify transformers and install warning signs according to Division 26 Section "Electrical Identification."

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

3.2 GROUNDING

A. Ground transformers and systems served by transformers according to Division 26 Section "Grounding" and as shown on drawings.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Arrange and pay for the services of a factory-authorized service representative to supervise the field assembly and connection of components, and the pretesting and adjustment of transformer components and accessories.

B. Pretesting: After completing system installation, perform the following preparations for tests:
   1. Make insulation-resistance tests for transformers.
   2. Make a continuity test for windings.
   3. Provide a set of Contract Drawings to the testing agency.
   4. Provide manufacturer's installation and testing instructions to the testing agency.

C. Test Objectives: To ensure transformer installation complies with Contract Documents, is operational within industry and manufacturer's tolerances, and is suitable for energizing.

D. Test Labeling: Upon satisfactory completion of tests for each transformer, attach a dated and signed "Satisfactory Test" label to the unit.

E. Schedule tests and provide notification at least one week in advance of test commencement.

F. Report: Submit a written report of observations and tests. Report defective materials and workmanship.

G. Tests: Include the following minimum inspections and tests according to the manufacturer's instructions. For test method and data correction factors, conform to IEEE Standard Test Codes C57.12.90 for liquid-filled units, and IEEE C57.12.91 for dry-type units.

1. Inspect accessible components for cleanliness, mechanical, and electrical integrity, for presence of damage or deterioration, and to ensure removal of temporary shipping bracing. Do not proceed with tests until deficiencies are corrected.
2. Inspect bolted electrical connections for tightness according to manufacturers' published torque values or, where not available, those of UL Standards 486A and 486B.
3. Insulation Resistance: Perform megohmmeter test of primary and secondary winding-to-winding and winding-to-ground according to the following:

WINDING RATING (VOLTS)	MINIMUM TEST [VOLTS (d.c.)]	MINIMUM RESISTANCE DRY TYPE	INSULATION (MEGOHMS) LIQUID FILLED
0 - 600	1,000	500	100
5,000 - 35,000	5,000	25,000	5,000

   a. Duration of Each Test: 10 minutes.
   b. Temperature Correction: Correct results for test temperature deviation from 20 degrees C standard.
4. Turns Ratio: Measure between windings at each tap setting. Measured ratios deviating more than 0.5 percent from the calculated ratio or the measured ratio for adjacent coil are not acceptable.
5. Winding Resistance: Measure for winding at nominal tap setting. Measured resistance deviating more than 1 percent from that of adjacent winding is not acceptable.
6. Liquid-Filled Transformer Insulation Power Factor Test: Determine overall dielectric loss and power factor for winding insulation. Limit test voltage to the line-to-ground voltage of the winding being tested.
7. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.4 ADJUSTING

A. After completing installation and cleaning, touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout the normal operating cycle of the facility. Record voltages and tap settings to submit with test results.

3.5 DEMONSTRATION

A. Training: Arrange and pay for the services of a factory-authorized service representative to demonstrate transformers and accessories and train Owner's staff. Include a minimum of 8 hours of training in operation and maintenance.

Provide both classroom training and hands-on equipment operation covering the following:

1. Safety precautions.
2. Features and construction of project transformers and accessories.
3. Routine inspection, test and maintenance procedures.
4. Routine cleaning.
5. Features, operation, and maintenance of integral disconnect and protective devices.
6. Interpretation of readings of indicating and alarm devices.
7. Fuse selection.
8. Protective relay setting considerations.
9. Features, operation and maintenance of separable insulated connector system.
10. Tap-changing procedures.

B. Schedule training with at least 7 days advance notice.

END OF SECTION 26 1200

SECTION 26 18 19 - MEDIUM VOLTAGE LIGHTNING ARRESTERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. All work specified in this section shall comply with the provisions of Section 26 01 00.

B. The contractor shall be responsible for the installation and operation of the equipment covered by this specification.

1.2 REFERENCED SPECIFICATIONS

A. Section 26 11 17- Unit Substations

B. Section 26 13 21 – Medium-Voltage Load Interrupter Switchgear

C. Section 26 12 00 – Pad-Mounted Transformers

D. Section 33 77 30 - Medium Voltage Metal Clad Switchgear

1.3 REFERENCED STANDARDS

A. IEEE 288 - ANSI C37.92 - IEEE Guide for Induction Motor Protection.

B. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Supplies.

C. IEEE 141 - IEEE Recommended Practices for Electric Power Distribution in Industrial Plants.

D. ANSI C37.20.2 - Metal Clad and Station-Type Cubicle Switchgear.

PART 2 - PRODUCTS

2.1 MANUFACTURERS/EQUIPMENT

A. Lightning arresters shall be metal oxide type distribution class gapless type as manufactured by GE, Eaton, ABB or approved equal.

2.2 ARRESTER RATINGS

A. Arrester ratings shall be as follows:

1. MCOV: as indicated on drawings

2. Continuous Voltage: as indicated on drawings

B. Arrester shall be rated to operate on a wye system: Solidly Grounded.

2.3 PRESSURE RELIEF CAPABILITY

A. The gapless metal oxide surge arresters shall be in compliance with the latest pressure relief standards for intermediate arresters (IEEE/ANSI C62.11) and shall be rated for a minimum of 16.1 KA.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Arresters shall be installed within the medium voltage equipment by the manufacturer.

B. The contractor shall make required field connections to the arresters at the project site after installing the protected equipment.

C. Ground per Section 26 05 26 – Grounding and Bonding for Electrical Systems.

END OF SECTION 26 18 19

SECTION 26 22 00 - DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. All work specified in this section shall comply with the provisions of Section 26 01 00.

B. Provide dry type transformer as shown on riser diagram.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Transformers shall be as manufactured by Square D, ABB, Cutler-Hammer, or approved substitute.

2.2 EQUIPMENT REQUIREMENTS

A. Description: Factory assembled and tested, air-cooled ventilated units for 60-Hz service on transformers 15 kVA and larger.

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

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.
2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
3. Grounded to enclosure.

E. Coils: Continuous windings without splices except for taps.

1. Coil Material: [Copper][Aluminum].
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Bolted.

F. Taps for Transformers 15 kVA AND Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

G. Insulation Class, Smaller than 15 kVA: 180 degrees C, UL-component-recognized insulation system with a maximum of 115 degrees C rise above 40 degrees C ambient temperature.

H. Insulation Class, 15 kVA and Larger: 220 degrees C, UL-component-recognized insulation system with a maximum of 150 degrees C rise above 40 degrees C ambient temperature.

I. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 degrees C maximum ambient and a 24-hour average ambient of 30 degrees C.
2. Indicate value of K-factor on transformer nameplate.
3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.
4. Neutral: Rated 200 percent of full load current for K-rated transformers.

K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.

L. Sound levels shall not exceed the following ranges:

1. 0-9KVA: 40db
2. 10-50KVA: 45db
3. 51-150KVA: 50db
4. 151-300KVA: 55db
5. 301-500KVA: 60db
6. 501-700KVA: 62db

M. Immediately prior to initial varnish impregnation entire core and coil assembly to be thoroughly dried in a preheat cycle, and then thoroughly baked to ensure that all volatiles have been driven off in process. Core and coil assembly to be internally isolated from enclosed through use of an effective vibration dampening system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide flexible conduit to and from transformer.

B. Install transformers in accordance with manufacturers' recommendations.

C. Provide trapeze type hangers for transformers supported from the structure or mount on the floor as shown on the drawings. Floor mounted transformers shall be securely anchored to a 4" reinforced concrete housekeeping pad. Provide working clearances as required by NEC.

D. Provide both primary and secondary protection by use of fuses or circuit breakers as shown on drawings.

END OF SECTION 26 22 00

SECTION 26 24 13 - CIRCUIT BREAKER DISTRIBUTION SWITCHBOARDS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The requirements of the Contract, Division 01, and Division 26 apply to work in this Section.

1.2 SECTION INCLUDES

A. Low Voltage, Front-Accessible and Front/Rear-Accessible switchboards with circuit breakers and as specified below and shown on the contract drawings.

1.3 REFERENCES

A. The low voltage switchboards and protection devices in this specification are designed and manufactured according to latest revision of the following standards unless otherwise noted.

1. ANSI 61.
2. ANSI/NEMA PB 2, Deadfront Distribution Switchboards.
3. ANSI/NEMA PB 2.1, General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.
4. ANSI/NFPA 70, National Electrical Code, latest version.
5. NEMA AB 1, Molded Case Circuit Breakers and Molded Case Switches
6. UL 489, Molded Case Circuit Breakers and Circuit Breaker Enclosures
7. UL 891, Dead Front Switchboards
8. UL 98, Enclosed and Dead Front Switches

1.4 DEFINITIONS

A. Front-Accessible only shall be as defined by UL 891 standard which requires that all line and load connections for phase, neutral, and ground conductors can be made and maintained from the front of the switchboard without access to the rear.

1.5 SYSTEM DESCRIPTION

A. The power system feeding the Switchboard is 480 volts, 60 Hertz, 3 phase, 4 wire, solidly ground wye

B. Switchboard(s) shall have front access for mounting against a wall

C. Switchboards shall be rear aligned.

1.6 SUBMITTALS

A. Manufacturer shall provide the following documents to owner for review and evaluation in accordance with general requirements of Division 01 and Division 26:

1. Product Data on specified product;
2. Shop Drawings on specified product;
3. Trip curves for each specified product.

1.7 INSTALLATION, OPERATION AND MAINTENANCE DATA

A. Manufacturer shall provide copies of installation, operation and maintenance procedures to owner in accordance with general requirements of Division 01 and Division 26.

1.8 QUALITY ASSURANCE (QUALIFICATIONS)

A. Low voltage switchboards shall be listed and/or classified by Underwriters Laboratories in accordance with standards listed in Article 1.3 of this specification.

1.9 DELIVERY, STORAGE, AND HANDLING

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

B. Ship each switchboard section in individual shipping splits for ease of handling. Each section shall be mounted on shipping skids and wrapped for protection.

C. Contractor shall inspect and report concealed damage to carrier within 48 hours.

D. Contractor shall store in a clean, dry space. Cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation.

E. Contractor shall handle in accordance with manufacturer's recommendations to avoid damaging equipment, installed devices, and finish. Lift only by installed lifting eyes.

1.10 PROJECT CONDITIONS (SITE ENVIRONMENTAL CONDITIONS)

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

B. Low voltage switchboards shall be located in well - ventilated areas, free from excess humidity, dust and dirt and away from hazardous materials. Ambient temperature of area will be between minus 30 and plus 25 degrees C (which is the maximum ambient temperature per UL 891 without the requirement to derate the switchboard). Indoor locations shall be protected to prevent moisture from entering enclosure.

1.11 WARRANTY

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

1.12 FIELD MEASUREMENTS

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

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. General Electric Company

B. Square D

C. Cutler-Hammer

D. Siemens

2.2 COMPONENTS

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

B. Standard Features

1. Switchboards shall be fully self-supporting structures with 90 inch tall vertical sections (excluding lifting eyes and pull boxes) bolted together to form required arrangement.
2. Switchboard(s) shall be NEMA 1.
3. Switchboard frame shall be die formed, 12 gauge steel with reinforced corner gussets. Frame shall be rigidly bolted to support cover plates (code gauge steel), bus bars and installed devices during shipment and installation.

4. All sections may be rolled, moved or lifted into position. Switchboards shall be capable of being bolted directly to the floor without the use of floor sills.
5. All switchboard sections shall have open bottoms and removable top plate(s) to install conduit.
6. Front-Access only switchboard sections shall be rear aligned for placement against a wall.
7. Series rated switchboards are not acceptable.
8. All covers shall be fastened by hex head bolts.
9. Provide hinged doors over metering compartments and individually mounted device compartments. All doors shall have concealed hinges and be fastened by hex head bolts.
10. Switchboard protective devices shall be furnished as listed on drawings and specified herein, including interconnections, instrumentation and control wiring. Switchboards and devices shall be rated for the voltage and frequency listed on the drawings.
11. Switchboard current ratings, including all devices, shall be based on a maximum ambient temperature of 25 degree C per UL Standard 891. With no derating required, temperature rise of switchboards and devices shall not exceed 65 degrees C in a 25 degree C ambient environment.
12. Switchboard Service Entrance sections shall comply with UL Service Entrance requirements including a UL service entrance label, incoming line isolation barriers, and a removable neutral bond to switchboard ground for solidly grounded wye systems.

C. Bus Bars

1. Bus bars shall be continuously silver-plated copper. Bus bars shall have sufficient cross sectional area to meet UL 891 temperature rise requirements. Phase and neutral bus ampacity shall be as shown in plans. For 4-wire systems, neutral shall have same ampacity as phase bus bar.
2. Bus bars shall be mounted on high impact, non-tracking insulated supports. Joints in the vertical bus are not permitted.
3. Bus bars shall be braced to withstand mechanical forces exerted during short circuit conditions as indicated in drawings, but in no case less than 65KA RMS SYM.
4. Bus joints shall be bolted with high tensile steel Grade 5 bolts. Belleville type washers shall be provided with aluminum bus. Welded connections are unacceptable.
5. Ground Bus shall be sized to meet UL 891. Ground bus shall extend full length of switchboard.
6. A-B-C bus arrangement (left to right, top to bottom, front to rear) shall be used throughout to assure convenient and safe testing and maintenance. Where special circuitry precludes this arrangement, bus bars shall be labeled.
7. All feeder device line and load connection straps shall be rated to carry current rating of device frame (not trip rating).
8. The main incoming bus bars shall be rated for the main protection device frame size or main incoming conductors, if there is no main device.

9. Main horizontal bus bars shall be fully rated and arranged for future extensions.

D. Utility Metering Compartments

1. A utility metering compartment is not required within the switchboard.

E. Main Incoming Compartment

1. Furnish switchboard(s) arranged for bottom entry of incoming cable.

   a. All lugs shall be tin-plated aluminum and UL listed for use with copper cable or aluminum cable. Lugs shall be rated for 75 degree C. Cable.
   b. Provide mechanical lugs in the quantity and size required per the contract drawings.

F. Main, Tie, and Feeder Devices

1. Main device shall be individually mounted, insulated case circuit breaker. Provide device as specified in appropriate article below.
2. Tie device(s), if included, shall be the same as the main device.
3. Feeder devices shall be group mount molded case circuit breakers or when larger than 1200 amps shall be individually mounted insulated case circuit breakers. Provide devices as specified in appropriate article below.
4. Each main and tie breaker shall have digital electronic trip units as described in Article 2.2.I.
5. Where indicated on the drawings, feeder circuit breakers with trip ratings greater than 250 amperes to 1000 amperes shall be UL listed as 100 percent continuous duty rated.
6. All circuit protective devices shall have the following minimum symmetrical current interrupting capacity: 85 kA as listed on the contract drawings.
7. Series rated feeders are not acceptable.

G. Molded Case Circuit Breakers

1. Molded case circuit breaker shall have the following symmetrical current interrupting capacity: 85 kA as listed on the contract drawings.
2. Thermal magnetic molded case circuit breakers may be provided for trip ratings 800 amps and below.
3. Group mounted breakers shall be modular mounted. The module shall be electrically connected to the switchboard bus by spring reinforced jaws. Mechanical connections to panel frame shall be separate from electrical connections. Mechanical connections shall be self-aligning, spring loaded locking devices. Locking device handles shall be able to be bolted to each side of the device to prevent accidental release of electrical connections.
4. Individually mounted molded case circuit breakers shall be stationary mounted.

5. Circuit breaker frames shall be constructed of a high-strength, molded, glass-reinforced polyester case and cover. Breakers shall have an over-center, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. The design shall provide common tripping of all poles. Breakers shall be suitable for reverse feeding.
6. Breakers shall have ON and OFF position clearly marked on escutcheon. Breakers shall include a trip-to-test means on the escutcheon for manually tripping the breaker and exercising the mechanism and trip latch.
7. Breakers shall include factory installed mechanical lugs. Lugs shall be UL listed and rated 75 or 60/75 degrees C as appropriate. Breakers shall be standard, or 80 percent rated.
8. Breakers shall have electronic trip units as shown on the drawings.
9. Breakers shall be 100% rated as shown on the drawings.

H. Insulated Case Circuit Breakers

1. Insulated case circuit breakers shall be individually mounted.
2. Main breakers shall be manually operated, stationary mounted. Feeder breakers (larger than 1200 amps) shall be manually operated, stationary mounted.
3. Breakers shall be constructed of a high dielectric strength, glass reinforced insulating case. The interrupting mechanism shall be arc chutes. Steel vent grids shall be used to suppress arcs and cool vented gases. Interphase barriers shall to isolate completely each pole.
4. Breakers shall contain a true two-step stored energy operating mechanism which shall provide quick make, quick break operation with a maximum five cycle closing time. Breakers shall be trip free at all times. Common tripping of all poles shall be standard.
5. Insulated Case circuit breakers shall be rated to carry 100 percent of their frame ampacity continuously.
6. A charging handle, close push-button, open push-button, and Off/On/Charge indicator shall be located on the breaker escutcheon and shall be visible with the breaker compartment door closed.
7. Where drawout breakers are specified, the drawout design shall permit the breaker to be withdrawn from an engaged position, to a test position, and to a disengaged position.
8. Breaker digital electronic trip units shall be as described in Article 2.2.I.

I. Digital Electronic Trip Unit for Circuit Breakers

1. The digital electronic trip unit shall consist of a solid state, microprocessor based programmer; tripping means; current sensors; power supply and other devices as required for proper operation.
2. As a minimum, the trip unit shall have the following protective functions:

    a. Adjustable current setting or long time pickup.
    b. Adjustable long time delay.
    c. Adjustable short time pickup and delay for main, and feeder.
    d. Adjustable instantaneous pickup.

e. Adjustable ground fault pickup and delay for main and feeder breakers.

3. As a minimum, the trip unit shall include the following features:

a. Long time and short time protective functions, if provided, shall have true RMS sensing technology.
b. Ground fault protective function, if provided, shall contain a memory circuit to integrate low level arcing fault currents with time, to sum the intermittent ground fault spikes.
c. High contrast liquid crystal display (LCD) unit shall display settings, trip targets, and the specified metering displays.
d. Multi-button keypad to provide local setup and readout of all trip settings on the LCD.
e. UL Listed interchangeable rating plug. It shall not be necessary to remove the trip unit to change the rating plug.
f. An integral test jack for testing via a portable test set and connection to a battery source.
g. A mechanism for sealing the rating plug and the trip unit.
h. Noise immunity shall meet the requirements of IEEE C37.90.
i. Display trip targets for long time, short time, and ground fault, if included.

4. Energy-Reducing Maintenance Switching with Local Status Indicator: All circuit breakers shall include an Energy-Reducing Maintenance Switch (ERMS).

a. The ERMS technology shall be provided to reduce arc energy during periods of maintenance. The system shall engage an independent, reduced instantaneous pickup and reduce total clearing time when activated.
b. The pick-up value shall be adjustable with a minimum of (5) settings (2.5 to 10 x In) to allow the greatest arc energy reduction without nuisance tripping.
c. With the ERMS technology active, total clearing time shall not exceed 40 msec for any fault currents above the pick-up value.
d. Activation and deactivation of the ERMS technology and local indication shall be accessible from the face of the trip unit without opening the circuit breaker door and exposing operators to energized parts. Recalibration or adjustment of trip unit parameters shall not be required when enabling / disabling the ERMS technology.

1) Breakers shall include a separate, local, lockable ERMS activation selector switch and pilot light indication.

2.3 METERING TRANSFORMERS

A. All instrument transformers shall be UL listed and classified as indicated in drawings.

B. Current Transformers shall be as shown on drawings with burden and accuracy to support connected meters and relays as required by ANSI/IEEE C57.13.

C. Potential transformers shall be as shown on drawings with burden and accuracy to support connected meters and relays as required by ANSI/IEEE C57.13.

2.4 FINISH

A. All steel surfaces shall be chemically cleaned prior to painting.

B. Exterior paint color shall be Light Gray ANSI 61 over phosphate - type rust inhibitor.

2.5 ACCESSORIES

A. Molded Case Circuit Breaker Accessories

1. Provide breaker accessories, UL listed for factory or field installation and common to all breaker frame sizes as indicated below and on the drawings:

a. Shunt trip: Shunt trip shall be powered by CT integral to switchboard
b. Auxiliary switch.
c. Bell alarm.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The following procedures shall be performed by the Contractor.

1. Examine installation area to assure there is enough clearance to install switchboard.
2. Check concrete pads for uniformity and level surface.
3. Verify that switchboards are ready to install.
4. Verify field measurements are as instructed by manufacturer.
5. Verify that required utilities are available, in proper location and ready for use.
6. Beginning of installation means installer accepts conditions.

3.2 INSTALLATION

A. Installation shall be performed by the Contractor.

1. Install per manufacturer's instructions.
2. Install required safety labels.

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide circuit breaker type panelboards as indicated on drawings and as specified in this section.

B. Refer to drawings for numbers of branch circuits, their ratings, number of poles, arrangements, etc.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS/EQUIPMENT

A. Provide panelboards by Square D, ABB, Siemens, or Eaton. Square D type designations are used to indicate type and quality of panelboards.

B. Lighting panelboards for 120/208-volts, 3-phase, 4-wire service shall be Square D type NQ.

C. Lighting panelboards for 277/480-volts, 3-phase, 4-wire service shall be Square D type NF.

D. Power panelboards for 120/208-volt, and 480/277-volt, 3-phase, 4-wire service shall be Square D I-Line distribution type.

E. Lighting and power panelboards and their associated circuit breakers shall be furnished with a short-circuit current rating greater than the available fault current shown on the panel schedules.

F. Series rated panelboards are not acceptable.

G. Provide panelboards of circuit breaker, dead-front safety type, UL labeled and meeting all applicable requirements of the National Electrical Manufacturers Association.

H. Provide panelboards with lugs (both main lugs and branch circuit lugs) suitable and UL approved for copper 75 degree C rated conductors.

I. Provide shunt trip and GFI breakers where indicated on panel schedule.

J. Provide electrically isolated neutral bars.

K. Provide separate ground bars complete with lugs or connectors on bar.

L. Provide panelboards with sequence phased bus bars or distributed phase bussing as indicated on drawings.

M. Provide panel doors equipped with chrome-plated locks and catches, all keyed alike. Provide two keys for each lock. Provide fronts with adjustable indicating trim clamps.

N. Provide thermal magnetic circuit breakers which are fully rated and temperature rated for a 40 degree C ambient. Breakers shall be quick-make, quick-break type with trip indication shown by handle position other than ON or OFF and with a common trip on all multi-pole breakers.

O. Where specific panelboard types, breaker types, or adjustable breaker devices are shown on the drawings, and the contractor elects to use another manufacturer or type, contractor will be responsible for additional cost incurred by the designer for evaluation of breaker coordination.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ground separate ground bars to panel boxes and to the main service entrance ground bus with a code-sized grounding conductor installed in the same conduit as the phase and neutral conductors.

B. Install all circuits which use a common neutral in accordance with the latest edition of the National Electrical Code, Article Nos. 210-4, 210-5, 215-4, and 220-4d. Balance all circuits to achieve not greater than 10% unbalanced neutral current in panel feeders.

C. Provide six circuit breaker handle lock-on devices for each lighting panelboard for installation by the contractor on circuits as directed by the Owner to prevent unauthorized personnel from turning off circuits to controls, unit heaters, clocks, night lights, etc. Turn the spare lock-on devices over to the Owner for his use.

D. Provide typed directory cards mounted under plastic on the doors of all panelboards. The directories shall indicate the type of devices being served, including the space number or space names in which the devices or fixtures are located.

E. Provide engraved Bakelite nameplates for all the circuit breakers in use on power panelboards. Indicate the device, panel, or motor being served with 1/4" high letters. Provide nameplates without engraving for the spare breakers and/or spaces. Secure all nameplates to the panelboard trim with two roundhead sheet metal screws.

F. Provide engraved Bakelite nameplates on the visible face of all lighting and power panels indicating the panel and emergency system branch designation in 3/8" letters. Secure the nameplates with a minimum of two round-head sheet metal screws. Normal power nameplates shall be black and emergency power nameplates shall be red.

G. Provide 7 sets of final as-built drawings for the panels after delivery of the panels for distribution by the Owner.

END OF SECTION 26 24 16

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide switches, receptacles, device plates, and other wiring devices as indicated on drawings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers include Leviton, Hubbell, Eagle, Arrowhart, Pass and Seymour, and Bryant. Leviton numbers are used for clarity.

2.2 SWITCHES

A. 20-Amp, 120/277 VAC:

1. Single pole: Leviton No. 1221-2W.
2. Three-way: Leviton No. 1223-2W
3. Single pole, weatherproof: Leviton No. 1221-2W with Steel City No. SW1-C weatherproof plate.
4. Single pole with pilot light (120 VAC): Leviton No. 1221-PLC.
5. Momentary contact switch: Leviton No. 1257.

B. Dimmers shall be universal (LED/CFL/MLV/Incandescent) slide dimmers equal to Leviton DSM10-1LZ.

2.3 RECEPTACLES

A. 20-Amp, 125-VAC, NEMA 5-20R:

1. Duplex type: Leviton No. 5362-W (white).
2. Ground fault circuit interrupter: Leviton No. MGFN2-W (white).
3. GFCI Duplex type, heavy-duty industrial grade, Weather and Tamper-Resistant: Leviton G5362-WTW (White).
4. Weatherproof “In Use”, extra-duty type cover: Leviton 5980-UCL.
5. Duplex type, heavy-duty industrial grade, Weather and Tamper-Resistant: Leviton TWR20-W (White).
6. Tamper resistant type: Leviton 5362-SGW (white).
7. Duplex isolated ground type: Leviton 5362-IGW (white).

2.4 MISCELLANEOUS DEVICES

A. Twist lock receptacle: Hubbell No. 23000-HG series or approved substitute.

B. Flush dryer receptacle, 30-amp, 125/250 VAC: Leviton No. 5207 with No. 84028 plate.

C. Flush range receptacle, 50-amp, 125/250 VAC: Leviton No. 5206 with No. 84028 plate.

D. Clock outlet: Leviton No. 5261CH.

2.5 DEVICE PLATES

A. Provide Leviton Series 84 stainless steel Leviton Series 80 nylon plates (white), red for emergency circuits, or approved substitute. Provide cast alloy or stamped metal plates on all exposed switches and receptacles.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mounting:

1. Mount all switches 46" above the finished floor to centerline of switch unless noted otherwise.
2. Mount all receptacles 18" above the finished floor to centerline of receptacle unless noted otherwise.
3. Mount weatherproof receptacles vertically.
4. Work devices to nearest block course using proper type outlet boxes as specified under [**Section 26 05 37**]. Check architectural and furniture drawings for counter (desk, special booth etc.) locations. Mount devices above work counters. Verify other special mounting conditions and locate devices as required.

B. Polarity: Properly wire all convenience outlets so that the hot wire, the neutral wire and the ground wire connect to the proper terminal on all receptacles.

C. Grounding: Install all receptacles in boxes specified under [**Section 26 05 37**], and install a No. 12 green ground wire from device grounding terminal back to the grounding bus in the panelboard and bond to outlet box.

D. Receptacles shown on the drawings as "special mounting height" shall be installed at mounting height as indicated on drawings. Where no mounting height is given and receptacles are above counters (or casework), they shall be mounted with centers 4" above top of counter. If the counter has a backsplash, receptacles shall be mounted with centers 4" above top of backsplash. Where special mounting height receptacles are not above counters and no mounting height is indicated, receptacle mounting heights shall match adjacent light switches or above counter receptacles. The Contractor shall coordinate the installation of all special mounting height receptacles with architectural design.

E. Install device plates in full contact with wall surface. Plates shall not project out from the wall.

F. Install device plates in full contact with surface-mounted box. Plates shall not project out from the edge of the box.

G. Receptacle plates for all receptacles in critical patient care areas shall be labeled to indicate the appropriate panel designations and circuit number. Plates shall be labeled by engraving on the plate or with other approved method. Use of laminated tape such as Dymotape is not acceptable.

END OF SECTION 26 27 26

SECTION 26 28 18 - SAFETY SWITCHES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide horsepower-rated, quick-make, quick-break, safety switches provided with the number of poles and fuses as required.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS/EQUIPMENT

A. Safety switches shall be as manufactured by General Electric, Square D Company, Cutler-Hammer, or approved substitute.

B. For 208- and 240-volt circuits, use general-duty type switches with Class R fuse clips. For 480-volt circuits, use heavy-duty type switches with Class R fuse clips.

C. Switches shall have arc shields, shall be of enclosed construction and fusible or non-fusible as indicated. Switches shall be rated for either 250-volt AC or 600-volt AC service as required.

D. Safety switches for all part-winding or two-speed motors requiring remote disconnect to be similar to Square D Series HLL-660, six-pole.

E. Switches shall have Electrical Interlock Kit with one normally open and one normally closed contact.

F. All switches shall be capable of interrupting locked rotor current of motor which it serves.

G. Enclosures to be NEMA-1 for interior use and NEMA-3R for exterior use unless noted otherwise.

H. Provide dual-element Bussman type FRN (250 volt) or type FRS (600 volt) fuses for any fusible safety switch serving a motor circuit.

I. For non-motor loads, provide dual element Bussman type LPN (250 volt) or type LPS (600 volt).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide non-fusible switches at remote motor locations (raintight where required) as indicated on drawings.

B. Mount switches to walls or adjacent to equipment enclosures using unistruts with a minimum of four bolts using toggle anchors for masonry construction, Phillips "Red Head" anchors for poured concrete construction and bolts, jumbo washers, lock washers and nuts for equipment enclosure mounting.

C. All safety switches to be identified with Bakelite nameplates.

END OF SECTION 26 28 18

SECTION 26 32 13 - DIESEL ENGINE DRIVEN GENERATOR SETS SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This specification includes packaged engine-generator sets for emergency power and standby power to be installed as per plans and specifications. Unit(s) shall provide for completely automatic unattended operation, for the duration of any loss of normal utility power. Unit(s) to be capable of reaching operating range within 10 seconds of initial start signal (NFPA 99, Chapter 3). Unit(s) shall be of a /KVA capacity as shown on plans.

B. Full-service responsibility for satisfactory operation and performance of this system shall rest with Division 26 contractor supplying the emergency power system. Engine/generator to be furnished with all necessary features and options to comprise a complete operable system when installed as per manufacturers' recommendations.

C. The generator set covered by these specifications shall be designed, tested, rated, assembled, and installed in strict accordance with all applicable standards below:

1. ISO8528
2. UL508
3. UL2200
4. UL142
5. Designed to allow for installed compliance to NFPA 37, NFPA 70, NFPA 99 and NFPA 110.

D. The authorized manufacturer's dealer shall provide a preventive maintenance agreement using qualified factory trained service personnel, for a period of 1-year minimum. The dealer shall provide genuine manufacturer's parts and filters, shall provide all recommended fluids, dealer labor, travel labor and travel mileage to complete the suggested preventive maintenance as defined in the manufacturer's Operation and Maintenance Manual.

E. The authorized manufacturer's dealer must have a generator set service location within 100 miles of the site. The dealer shall have a rental fleet with similar sized generator sets to the generator set(s) being supplied.

F. Unit to be equipped for outdoor installation as shown on drawings.

1.2 RELATED SECTIONS

A. 26 36 00 - Automatic Transfer Switch (ATS)

B. 26 05 26 - Grounding and Bonding for Electrical Systems

1.3 SUBMITTALS

A. Contractor shall provide as part of submittal data: Complete, composite electrical and mechanical drawings indicating control wiring routing, quantity and size, as well as size and suggested routing of coolant, fuel lines and exhaust lines. If options or special equipment other than those specified below are required, they shall be included in the submittals.

B. Engine-generator submittals shall include the following information:

1. Factory published specification sheet.
2. Manufacturer's catalog cut sheets of all auxiliary components such as battery charger, control panel, enclosure, etc.
3. Dimensional elevation and layout drawings of the generator set, enclosure and transfer switchgear and related accessories.
4. Weights of all equipment.
5. Concrete pad recommendation, layout, and stub-up locations of electrical and fuel systems.
6. Interconnect wiring diagram of complete emergency system, including generator, switchgear, day tank, remote pumps, battery charger, control panel, and remote alarm indications.
7. Engine mechanical data, including heat rejection, exhaust gas flows, combustion air and ventilation air flows, fuel consumption, etc.
8. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion and telephone influence factor.
9. Generator resistances, reactances, and time constants.
10. Generator locked rotor motor starting curves.
11. Manufacturer's documentation showing maximum expected transient voltage and frequency dips, and recovery time during operation of the generator set at the specified site conditions with the specified loads.
12. Manufacturer's and dealer's written warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS/EQUIPMENT

A. Emergency generator shall be by Caterpillar, Generac, Kohler, Cummins, or approved equal.

2.2 GENERAL REQUIREMENTS

A. Genset Requirements: The generator set shall be Standby Duty rated at 500 ekW, 625 kVA, 1800 RPM, 0.8 power factor, 480 V, 3-Phase, 60 hertz, including radiator fan and all parasitic loads. Generator-set shall be sized to operate at the specified load at a maximum ambient of 104° F (40° C) and altitude of [292 feet (89 m)]. System voltage to be 480/277-volts, 3-phase, 4-wire, 60 Hz., .8 power factor.

1. Standby Power Rating: [500**]** kW

2. Power is available for the duration of an emergency outage.
3. Average Power Output = 70% of standby power.
4. Load = Varying.
5. Typical Hours/Year = 200 Hours.
6. Maximum Expected Usage = 500 hours/year.
7. Typical Application = Standby.

2.3 ENGINE

A. Engine shall be full diesel, compression ignition, liquid-cooled, and capable of producing the rated KW at a governed speed of 1800 rpm as specified under job site conditions. Engine to be equipped with electric starting, battery charging generator, electronic governor, fuel filters, oil filters, air cleaners, cooling system, and other equipment to provide a complete operable system. Selling distributor to be a factory authorized distributor of the diesel engine utilized in the standby engine generator system.

B. The engine will utilize in-cylinder combustion technology, as required, to meet applicable EPA non-road regulations and/or the EPA NSPS rule for stationary reciprocating compression ignition engines. Additionally, the engine shall comply with the State Emission regulations at the time of installation/commissioning. Actual engine emissions values must be in compliance with applicable EPA emissions standards per ISO 8178 – D2 Emissions Cycle at specified ekW / bHP rating.

2.4 COOLING

A. The generator set shall be equipped with rail-mounted, engine-driven radiator with blower fan and all accessories. The cooling system shall be sized to operate at full load conditions and 104°F ambient air entering the room or enclosure (if an enclosure is specified). The generator set supplier is responsible for providing a properly sized cooling system based on the enclosure static pressure restriction. Please assume a 7ºF air to core temperature rise across the engine.

B. Engine shall be equipped with thermostatically controlled water jacket heater to maintain minimum 80-degrees F water jacket temperature under ambient conditions. Vendor shall consult with and coordinate special extreme cold weather needs with Electrical Engineer. Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity. Heater shall include a circulation pump. Provide isolation valves that allow for change out of the heater without having to drain the entire system.

C. Complete cooling system shall be filled with anti-freeze coolant (0 degrees F or less as required by the extreme of local weather conditions) supplied by the vendor at start-up.

2.5 OUTDOOR INSTALLATIONS

A. Sound Attenuated Enclosure: The complete diesel engine generator set, including generator control panel engine starting batteries shall be enclosed in a factory assembled, sound attenuated enclosure mounted on the fuel tank base.

1. A weather resistant, sound attenuated enclosure of 14-gauge steel with electrostatically applied powder coated baked polyester paint. **t**he enclosure shall have a resulting sound level of 75_dba @_23 feet with the genset running under full load. It shall consist of a roof, side walls, and end walls.
2. Fasteners shall be either zinc plated or stainless steel.
3. Internally mounted exhaust silencer to meet sound level listed above.
4. Enclosure door shall include control panel viewing window in order to view generator controller without having to access the generator enclosure. No exceptions.
5. Acoustical foam shall be provided between all supports and inside doors and sound baffles or air intake and air discharge.
6. NFPA 110 Level 1 outdoor installations may require motorized automatic dampers at intake and discharge and space heater to maintain 40°F internal temperature.
7. Load center sized for generator ancillary components.
8. Radiator Air Discharge must be vertically discharged without exception.

2.6 SILENCERS AND BATTERIES

A. For indoor generator sets, furnish and install super critical grade exhaust silencer. VEE-type engines shall have dual inlet, single outlet. Condensate trap, pet cock drain shall be installed in the silencer. A flexible section, 36 inches minimum, shall be provided between the engine exhaust manifold and the silencer. This section shall be carbon steel bellows type. The silencer shall be provided with mounting brackets for ceiling suspension. The silencer shall be installed from the equipment room ceiling in a horizontal position. The silencer shall be mounted so that its weight is not supported by the engine nor will exhaust system growth due to thermal expansion be imposed on the engine.

B. Engine/generator manufacturer shall specify exhaust line size required for acceptable back pressure. Exhaust line shall be Schedule 40 pipe and be connected to engine manifold through seamless, flexible, carbon steel bellows type connection. Exhaust systems installed inside structure shall be fully insulated (under Division 23) and lines passing through walls shall pass through sleeves.

C. Provide starting batteries capable of starting unit in time specified under installed conditions and capable of (2) 75-second periods of engine cranking. Batteries to be installed in steel, insulated rack(s).

D. Battery heater pads to be furnished on outdoor installations.

E. Provide batteries of the heavy-duty, maintenance-free lead-acid type, plastic case, shipped dry with electrolyte installed at start-up. Battery cables to be sized and provided by engine/generator vendor. Battery voltage shall be compatible with the starting system.

F. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

1. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
2. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from -40°C to +60°C to prevent overcharging at high temperatures and undercharging at low temperatures.
3. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to ±10%.
4. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
5. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
6. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.7 FUEL TANKS

A. Subbase Fuel Tank:

1. Provide a double wall sub-base tank constructed to meet all local codes and requirements. A fuel tank base of 24 hour capacity (for NFPA 110 Level 1 systems provide 133% capacity) shall be provided as an integral part of the enclosure. It shall be contained in a rupture basin with 110% capacity. The tank shall meet UL142 standards. A locking fill cap, a mechanical reading fuel level gauge, low fuel level alarm contact, normal and emergency vent extensions to 12', and fuel tank rupture alarm contact shall be provided.
2. Provide 5 Gallon Fuel Fill spill containment with overfill prevention valve (without exception).

2.8 GENERATOR

A. The synchronous generator shall be dual bearing, self-ventilated, drip-proof design in accordance with NEMA MG 1 and directly connected to the engine flywheel housing with a flex coupling. The generator shall meet performance class G2 of ISO 8528.

1. The excitation system shall be permanent magnet and enable the alternator to sustain 300% of rated current.
2. Form Wound 1500kW and above and above 600V, Random Wound below 1500kW.
3. Rotor/Stator Temperature rise at 40^{O} Ambient: 105^{O} C.
4. Insulation Class H.
5. Subtransient Reactance no greater than 12%.

B. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

C. All load connections shall be made up in rear mount junction box. Generator construction to allow load connections to be made on top, bottom or either side of junction box.

D. Digital Voltage Regulator:

1. The digital voltage regulator shall be microprocessor based with fully programmable operating and protection characteristics. The regulator shall maintain generator output voltage within +/- 0.25% for any constant load between no load and full load. The regulator shall be capable of sensing true RMS in three phases of alternator output voltage or operating in single phase sensing mode. The voltage regulator shall include a VAR/Pf control feature as standard. The regulator shall provide an adjustable dual slope regulation characteristic in order to optimize voltage and frequency response for site conditions. The voltage regulator shall include standard the capability to provide generator paralleling with reactive droop compensation and reactive differential compensation.
2. The generator set controller shall allow system parameter setup and monitoring and provide fault alarm and shutdown information through the controller. A PC-based user interface shall be available to allow viewing and modifying operating parameters in a Windows compatible environment.

E. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.

1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
2. Ground-Fault Protection: Comply with NFPA 70, signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.
3. Energy Reduction Maintenance Setting (ERMS): Provide ERMS switch on breakers 1200A and above.
4. Trip Settings: Selected to coordinate with generator thermal damage curve.
5. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
6. Suitable for Service Entrance

F. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

2.9 GENERATOR CONTROL PANEL

A. 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: The generator set control shall be tested and certified to the following environmental conditions:

1. –40°C to +70°C Operating Range
2. 100% condensing humidity, 30°C to 60°C
3. IP22 protection for rear of controller; IP55 when installed in control panel.
4. 5% salt spray, 48 hours, +38°C, 36.8V system voltage.
5. Sinusoidal vibration 4.3G's RMS, 24-1000Hz.
6. Electromagnetic Capability (89/336/EEC, 91/368/EEC, 93/44/EEC, 93/68/EEC, BS EN 50081-2, 50082-2).
7. Shock: withstand 15G.

C. Functional Requirements: The following functionality shall be integral to the control panel.

1. Standard ISO labeling
2. The control shall include a minimum 33 x 132 pixel, 24mm x 95mm, positive image, transflective LCD display with text-based alarm/event descriptions.
    a. The control shall include a minimum of 3-line data display.
    b. Audible horn for alarm and shutdown with horn silence switch.
3. Multiple language capability.
4. Remote start/stop control.

5. Local run/off/auto control integral to system microprocessor.
6. Cooldown timer.
7. Speed adjust.
8. Lamp test.
9. Emergency stop push button.
10. Voltage adjust.
11. Voltage regulator V/Hz slope – adjustable.
12. Password protected system programming.

D. Digital Monitoring Capability: The controls shall provide the following digital readouts for the engine and generator. All readings shall be indicated in either metric or English units.

1. Engine:

   a. Engine oil pressure
   b. Engine oil temperature
   c. Engine coolant temperature
   d. Engine RPM
   e. Battery volts
   f. Engine hours
   g. Engine crank attempt counter
   h. Engine successful start counter
   i. Service maintenance interval
   j. Real time clock
   k. Engine exhaust stack temperature
   l. Engine main bearing temperature

2. Generator:

   a. Generator AC volts (Line to Line, Line to Neutral and Average)
   b. Generator AC current (Avg and Per Phase)
   c. Generator AC Frequency
   d. Generator kW (Total and Per Phase)
   e. Generator kVA (Total and Per Phase)
   f. Generator kVAR (Total and Per Phase)
   g. Power Factor (Avg and Per Phase)
   h. Total kW-hr
   i. Total kVAR-hr
   j. % kW
   k. % kVA
   l. % kVAR
   m. Generator bearing temperature
   n. Generator stator winding temperature

3. Voltage Regulation:

   a. Excitation voltage
   b. Excitation current

E. Alarms and Shutdowns: 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:

1. Engine Alarm/Shutdown

    a. Low oil pressure alarm/shutdown
    b. High coolant temperature alarm/shutdown
    c. Loss of coolant shutdown
    d. Overspeed shutdown
    e. Overcrank shutdown
    f. Emergency stop shutdown
    g. Low coolant temperature alarm
    h. Low battery voltage alarm
    i. High battery voltage alarm
    j. Control switch not in auto position alarm
    k. Battery charger failure alarm

2. Generator Alarm/Shutdown

    a. Generator phase sequence
    b. Generator over voltage
    c. Generator under voltage
    d. Generator over frequency
    e. Generator under frequency
    f. Generator reverse power (real and reactive)
    g. Generator overcurrent

3. Voltage Regulator Alarm/Shutdown

    a. Loss of excitation alarm/shutdown
    b. Instantaneous over excitation alarm/shutdown
    c. Time over excitation alarm/shutdown
    d. Rotating diode failure

F. Inputs and Outputs:

1. Programmable Digital Inputs: 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: 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: The control shall include the ability to operate two (2) discrete outputs, integral to the controller, which are capable of sinking up to 300mA.

G. Maintenance: 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:

1. Engine running hours display.
2. Service maintenance interval (running hours or calendar days).
3. Engine crank attempt counter.
4. Engine successful starts counter.
5. 40 events are stored in control panel memory.
6. 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:

    a. Day of week
    b. Time of day to start
    c. 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.
2. Remote Monitoring Software: 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 dates 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.

2.10 REMOTE ANNUNCIATOR

A. Provide a remote annunciator to meet the requirements of NFPA 99/110, Level 1.

1. Remote Annunciator shall include a lamp test pushbutton, alarm horn and alarm acknowledge pushbutton.
2. Provide the following individual light indications for protection and diagnostics.

    a. Overcrank
    b. Low coolant temperature
    c. High coolant temperature warning
    d. High coolant temperature shutdown
    e. Low oil pressure warning
    f. Low oil pressure shutdown
    g. Overspeed
    h. Low coolant level
    i. EPS supplying load
    j. Control switch not in auto
    k. High battery voltage

l. Low battery voltage
m. Battery charger AC failure
n. Emergency stop
o. Spare
p. Spare

3. Ability to be located up to 4000 ft from the generator set.
4. Remote E-Stop: Provide a remote e-stop in a NEMA 1 enclosure with break-glass cover.
5. Remote annunciator panel shall be mounted where shown on the drawings.

PART 3 - EXECUTION

3.1 PROJECT SPECIFIC FACTORY EQUIPMENT TESTS

A. 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. Full load run.
2. Maximum power.
3. Voltage regulation.
4. Transient and steady-state governing.
5. Single-step load pickup.
6. Safety shutdown.

3.2 INSTALLATION REQUIREMENTS

A. Entire unit shall be installed in accordance with manufacturers' recommendations.

B. Mounting: Complete engine/generator and all mounted accessories shall be assembled on a common channel steel base. Fuel oil lines and lube oil drain shall terminate in base. Lube oil drain line shall be brought out to beyond the base to facilitate changing of the oil. Flexible fuel line sections (18" long) to be installed between base and fuel lines. Heavy-duty, steel spring vibration isolators shall be installed between the base and mounting pad. Isolators shall be sized and located as recommended by Generator Manufacturer.

C. Contractor shall provide the services of a factory-trained engineer for periodic job site visits during installation to ensure that the system is being installed in accordance with manufacturers' recommendations.

D. Complete engine/generator system shall be tested after installation to ensure that the engine/generator, automatic transfer switch, alarm annunciators, and all other equipment function in accordance with the specifications.

E. After installation, a 4-hour full load test shall be conducted by the distributor's engineer. This test shall be conducted using available building load, plus temporary load bank capacity so that full nameplate reading is utilized during test. Temporary load banks shall be furnished by the generator distributor and connected by Division 26 contractor. Test data shall be recorded and become a part of the three (3) Owners Manuals to be supplied.

F. After Owner acceptance, Factory Representative shall provide a minimum of one (1) day of Owner training in the complete operation and maintenance of the automatic transfer switch system and generator system. The training session for the automatic transfer switch system and generator system shall be scheduled on a separate day from the startup and testing day and shall be scheduled at least two weeks in advance with the Owner and before building acceptance.

G. Ground the engine generator frame and enclosure using an equipment grounding conductor sized in accordance with the NEC. Ground generator neutral on 4-pole (switched neutral) applications.

END OF SECTION 26 32 13

SECTION 26 33 05 - UNITERRUPTIBLE POWER SYSTEM UPS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Uninterruptible Power System shall be a continuous duty, bi-polar, solid-state uninterruptible power system, designed to provide emergency power to critical loads. The unit shall provide power conditioning and power distribution at all phases of operation even during the emergency power mode. The system shall consist of a microprocessor controlled, solid state inverter, power purification system, battery charger, sealed maintenance free battery charger, sealed maintenance free batteries, and monitor system.

1.2 REFERENCED STANDARDS

A. International Organization for Standardization (ISO):

1. ISO 9001, "Quality Management Systems - Requirements."
2. ISO 14001, “Environmental Management Systems - Requirements with Guidance for Use”

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

1. ANSI/IEEE C62.41, "Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits" (copyrighted by IEEE, ANSI approved)

C. National Electrical Manufacturers Association (NEMA):

1. NEMA PE 1, " Uninterruptible Power Systems (UPS) - Specification and Performance Verification"

D. National Fire Protection Association (NFPA):

1. NFPA 70, "National Electrical Code" (copyrighted by NFPA, ANSI approved) - hereafter referred to as NEC

E. Underwriters Laboratories, Inc. (UL):

1. UL 1778, 5th edition, "Standard for Uninterruptible Power Supply Equipment" (copyrighted by UL, ANSI approved)
2. UL 891, "Standard for Dead-Front Switchboards" (copyrighted by UL, ANSI approved)
3. UL 1558, "Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear”

F. International Electrical Commission (IEC):

1. IEC 62040-1: 2008 (First Edition) + Am 1: 2013 “General and safety requirements for UPS”
2. IEC 62040-2: 2016 Category C2, “Electromagnetic compatibility (EMC) requirements”
3. IEC 62040-3, “Uninterruptible Power Systems - Method of Specifying the Performance and Test Requirements”

G. FCC:

1. FCC part 15 Subpart B Class A.

1.3 INFORMATIONAL SUBMITTALS

A. System bill of materials.

B. Product technical specifications or equipment brochures.

C. System diagram.

D. Installation manual.

1.4 QUALITY ASSURANCE

A. Factory Testing

1. Prior to shipment the manufacturer shall complete a documented test procedure to test functions of the UPS module and batteries (via a discharge test), when supplied by the UPS manufacturer, and warrant compliance with this Section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project site in supplier’s or manufacturer’s original wrappings and containers, labeled with supplier’s or manufacturer’s name, material or product brand name, and lot number, if any.

B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

C. Products shall be packaged in a manner to prevent penetration by debris and to allow safe delivery by modes of ground transportation and air transportation where specified.

D. Equipment shall be protected against extreme temperature and humidity and shall be stored in a conditioned or protected environment.

1.6 PROJECT CONDITIONS

A. Do not install solid state UPS until space is nominally dry.

B. Environmental Requirements

1. Storage ambient temperature:

a. -25 °C to 55 °C (-13 °F to 131 °F) for UPS.
b. -15 °C to 40 °C (5 °F to 104 °F) for batteries.

2. Operating ambient temperature:

a. 0 °C to 40 °C (32 °F to 104 °F) without load derating.
b. From 40 °C to 50 °C (104 °F to 122 °F) with load derating.

3. Operating relative humidity: 0 to 95%, non-condensing.

1.7 WARRANTY

A. Special Warranty

1. UPS: The UPS shall be covered by a full parts and labor warranty from the manufacturer for a period of 12 months from date of acceptance by the Owner
2. Battery: The battery manufacturer's warranty shall be passed through to the final Owner and shall match the UPS warranty.

PART 2 - PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

A. UPS equipment shall be as manufactured by Schneider, Eaton, Liebert, or approved substitute.

2.2 GENERAL SPECIFICATIONS

A. The UPS shall be housed in a freestanding cabinet with casters. Maintenance shall be possible from the front.

B. The UPS shall be in a self-contained cabinet and shall be sized per the construction drawings.

1. 100 kW. Plans show 1.5MV- adjust all entries in the spec referring to capacity.

C. Live swap of power modules in any operation mode shall be possible.

D. Output power factor: 1.0.

E. Backfeed protection shall be included in equipment.

F. The UPS will be fed by 3 phase 4 wire 481V service from switchgear.

G. The UPS shall contain a static bypass switch and a display. The UPS shall be of the double conversion on-line topology with power factor corrected inputs.

1. The UPS shall be sized per construction drawings.
2. The UPS battery shall be sized for run time indicated on construction drawings based on UPS application.

H. The UPS shall be using a modular design in which power functions, static bypass, and system control are embedded in modules for optimal MTTR.

I. The UPS shall have a short circuit rating of 65 kA RMS.

J. The UPS shall be tested against EMC (electromagnetic compatibility) according to FCC part 15 Subpart B Class A.

2.3 INPUT SPECIFICATION

A. Nominal input voltage rating: As indicated on darwings.

B. Input voltage window: 408 V to 552 V.

C. Input frequency range: 40-70 Hz.

D. Input power factor:

1. 0.99 at load >50%
2. 0.95 at load >25%

E. Total harmonic distortion:

1. 50 kW, 100 kW, and 150 kW: < 3%
2. 20-40 kW, 60-80 kW, and 120 kW: < 5%

2.4 OUTPUT SPECIFICATION

A. Nominal output voltage rating: Review UPS one line shows 480 to 480 with separate transformer.

1. For emergency lighting UPS, output shall be 480V 3PH 4W.
2. For equipment UPS, output shall be 480V 3 PH 3W for delta connection to dry-type transformer.

B. Output voltage tolerance: +/- 1% for symmetrical loads.

C. Dynamic load response:

1. +/- 5% after 2 ms
2. +/- 1% after 50 ms

D. Output frequency: 60 Hz.

E. Output voltage harmonic distortion:

1. <1% at 100% linear load Schneider VX noted on one line is <2% @100% linear load, <3% at 100% non-linear load per the VX planning guide
2. <5% at 100% non-linear load

F. Overload capability:

1. 150% for 1 minute (normal operation)
2. 125% for 10 minutes (normal operation)
3. 125% for 1 minute (battery operation) 115% per planning guide
4. 125% continuous (bypass) 110% per planning uide
5. 1000% for 100 ms (bypass)

G. Output power factor: 1.0

H. Audible noise at full load:

1. 57 dBA at 70% load 62dB at 70% per planning guide
2. 64 dBA at 100% load 68dB @ 100% per planning guide – match up other characteristics with UPS that is basis of design.

2.5 OPERATION MODES

A. Normal: In normal operation, the UPS supports the load with conditioned power.

B. Battery: If the utility/mains supply fails, the UPS transfers to battery operation and supports the load with conditioned power from the DC source.

C. Requested static bypass: The UPS can be transferred to requested static bypass following a command from the display. During static bypass operation, the load is supplied from the bypass source. If a fault is detected, the UPS will transfer to normal operation or forced static bypass operation. If there is an interruption to the utility/mains power supply during requested static bypass operation, the system will transfer to battery operation.

D. Forced static bypass: The UPS is in forced static bypass following a command from the UPS system or because the user has pressed the inverter OFF button on the UPS. During forced static bypass operation, the load is supplied directly by the bypass source.

E. Internal maintenance bypass: When the internal maintenance bypass breaker (IMB) is closed, the UPS transfers to internal maintenance bypass operation. The load is supplied with unconditioned power from the bypass source. Service can be performed only on power modules, the static bypass switch module, and on the controller box during internal maintenance bypass operation. The internal maintenance bypass breaker IMB can only be used in single systems with no external maintenance bypass breaker.

F. External maintenance bypass: When the maintenance bypass breaker (MBB) is closed in the external maintenance bypass panel/cabinet, the UPS transfers to external maintenance bypass operation. The load is supplied with unconditioned power from the bypass source. Service can be performed on the entire UPS during external maintenance bypass.

G. Static bypass standby: The UPS enters static bypass standby if the UPS is prevented from entering forced static bypass and the other UPS units of the parallel system can support the load. In static bypass standby, the output of the specific UPS is off. The UPS automatically changes to the preferred operation mode when possible. Note: If the other UPS units cannot support the load, the parallel system enters forced static bypass. The UPS in static bypass standby will then transfer to forced static bypass.

H. ECO mode: ECO mode allows the UPS to be configured to use requested static bypass, with the load supplied through the bypass, as the preferred operation mode under predefined circumstances. If a fault is detected (bypass voltage out of tolerance, output voltage out of tolerance, etc.), the UPS will immediately transfer to normal operation or forced static bypass. The main advantage of ECO mode is a reduction in the consumption of electrical power. In case of interruption to the utility/mains supply, the UPS transfers to inverter operation for a continuous supply of the load. The batteries are charged when the UPS is in ECO mode.

I. ECOnversion mode: ECOnversion allows the UPS system to supply the active part of the load through the static bypass. The inverter is kept running in parallel with the bypass source and supplies the reactive part of the load. The input power factor of the UPS is, regardless of the load power factor, maintained close to unity as the reactive part of the load is significantly reduced in the UPS input current. In case of an interruption to the utility/mains supply, the inverter immediately maintains the output voltage so that breaks or drops during the transfer from ECOnversion mode are practically eliminated. The batteries are charged when the UPS is in ECOnversion mode.

2.6 COMPONENTS

A. Rectifier

1. The UPS shall include an active power factor corrected rectifier.
2. The input current limiter shall be designed to:

   a. Fast battery recharge:

      1) 80% of the UPS output rating at <40% load
      2) 20% of the UPS output rating at 100% load

   b. Provide regulation with input deviation of up/down to +/-15% of the nominal input voltage.

3. The battery charging shall keep the float voltage of

    a. 545-654 VDC for 40-48 blocks (50 kW, 100 kW, 120 kW, and 150 kW).

4. The battery charging voltage shall be compensated against temperature variations (battery temperature compensation) to always maintain optimal battery float charging. Temperature compensation rate shall be 3.3 mV/degree/cell for ambient temperatures > 25 °C and 0mV/°C for ambient temperatures < 25 °C.
5. Input power factor shall be 0.98 lagging at 100% load without the use of passive filters. Rectifier shall employ electronic waveform control technology to maintain the current sinusoidal.
6. Pulse Width Modulation (PWM) current control shall be used. Digital Signal Processors (DSP) shall be used for all monitoring and control tasks. Analog control shall not be acceptable.

B. Inverter

1. The inverter shall consist of fast switching IGBTs.
2. The inverter shall be a 3-level hybrid inverter.\
3. Inverter shall be PWM controlled using DSP logic. Analog control shall not be acceptable.\
4. The inverter modules shall be rated for an output power factor at 1.0.
5. Nominal output voltage shall be 480 V 3-phase.

C. Static bypass switch

1. The static bypass switch shall consist of fully rated Silicon Controlled Rectifiers (SCRs). Partly rated SCRs with a wraparound contactor shall not be acceptable.
2. The static bypass switch shall be of modular design with connectors at the rear.
3. The static bypass switch shall automatically transfer the load to bypass supply without interruption after the logic senses one of the following conditions:

    a. Inverter overload beyond rating.
    b. Battery runtime expired and bypass available.
    c. Inverter inoperable.
    d. Control system inoperable.

4. The static bypass switch shall automatically retransfer from bypass to the inverter.
5. The inverter shall be active (on).
6. The static bypass switch shall be equipped with a manual means of transferring the load to bypass and back to inverter.

D. Battery

1. General: The UPS shall use a Lithium-ion battery, designed for auxiliary power service in a UPS application.

   a. End of discharge voltage at full load: 384 VDC for 40 blocks (50 kW, 100 kW, 120 kW, and 150 kW UPS).
   b. Battery charge current limit: The selection shall be made from the display. The battery charge current limit should be software and hardware current limit.
   c. The battery charging circuit shall remain active when the PFC operates normally.

E. Lithium-ion Battery Solution:

1. The battery cabinet shall feature lightweight, compact, long-life Lithium-ion batteries which provide energy to support the load during a momentary loss of input power to the rectifier.
2. Each battery cabinet shall require front access only for installation, service, and maintenance.
3. Each battery cabinet shall feature a DC rated circuit breaker. The circuit breaker within the battery cabinet shall only provide protection to the battery string within that battery cabinet.

F. Battery monitoring:

1. Battery monitoring shall be provided at system level.
2. The UPS shall incorporate a battery capacity test that will determine the available runtimes.
3. The Lithium-ion battery status shall communicate with the UPS via dry contacts.

2.7 MECHANICAL

A. The UPS shall be housed in a freestanding cabinet with casters.

B. The cable entry shall be from the bottom or rear of the UPS.

C. The cabling section shall be large enough to accept copper cables.

D. The UPS shall meet an ingress level of minimum IP21.

E. The UPS shall offer an option of using 2-hole lugs to prevent risk of lug rotation after cable connection.

2.8 DISPLAY, CONTROLS, AND ALARMS

A. A color touch screen display shall be located on the front of the UPS.

B. The following metered data shall be available on the display:

1. Year, month, day, hour, minute, second of occurring events.
2. Input voltage.
3. Input current.
4. Input frequency.
5. Output voltage.
6. Output current.
7. Output frequency.
8. Battery voltage.
9. Battery current.
10. Battery temperature.

C. The display shall allow the user to display active alarms.

D. The following controls or programming functions shall be accomplished by use of the display unit.

1. Silence audible alarm.
2. Set the alphanumeric display language.
3. Display and set the date and time.
4. Enable or disable the automatic restart feature.
5. Transfer load to and from static bypass.
6. Test battery condition on demand.

E. LEDs for indication of operation mode.

F. Push button user controls:

1. Inverter ON.
2. Inverter OFF.

G. For purposes of remote communications with the UPS, a network management card shall be integrated.

2.9 ACCESSIBILITY

A. Software and connectivity

1. The Ethernet Web/SNMP Adaptor shall allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP network environments. The management information base (MIB) shall be provided in MIB formats. The SNMP interface adaptor shall be connected to the UPS via the RJ45 serial port on the standard communication interface board.
2. The UPS shall offer a Modbus interface.
3. The UPS shall be equipped with eight dry contacts (four inputs, four outputs) for user-assignable alarms or remote monitoring.

B. Remote UPS monitoring

1. The UPS system shall be interfaced with the building BAS system for monitoring of status and tracking of alarms.

2. Three methods of remote UPS monitoring shall be available:
3. Smartphone application: With remote monitoring and live system status and remote alarms.
4. Web monitoring: Remote monitoring shall be available via a web browser such as Internet Explorer.
5. Simple Network Management Protocol (SNMP): Remote UPS monitoring shall be possible through a standard MIB II compliant platform.

C. Software compatibility
The UPS manufacturer shall have available software to support shutdown and or remote monitoring for the following systems.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Preparation and installation shall be in accordance with reviewed product data, final shop drawings, manufacturer's written recommendations, and as indicated on the Drawings.

3.2 MANUFACTURER ASSISTED START-UP

A. A manufacturer assisted UPS start-up shall be available, manufacturer trained service personnel shall perform the following inspections, test procedures, and on-site training:

B. Inspect equipment for signs of damage, verify installation per manufacturer's instructions, inspect cabinents for foreign objects, inspect batteries

C. Check all UPS, external battery cabinets internal power wiring connections; Check all UPS, external battery cabinets terminal screws, nuts, and/or spade lugs for tightness

D. Verify correct input and bypass voltage, correct phase rotation of all mains connections, correct UPS control wiring and terminations, voltage of batteries, and neutral and ground conductors are properly landed.

E. Ensure proper system start-up, verify proper firmware control functions, verify proper firmware bypass operation, verify proper maintenance bypass switch operations, verify system set points, verify proper inverter operation and regulation circuits, simulate input power failure, verify proper charge operation, document, sign and date all test results

F. **On-Site Operational Training**: During the manufacturer assisted start-up, operational training for site personnel shall include LED indicators, start-up and shutdown procedures, maintenance bypass and AC disconnect operation, and alarm information.

3.3 LOAD TEST

A. The installed system shall be tested per manufacturers recommendations based on application (emergency lighting or equipment).

1. Input voltage (all three phases, for each module).
2. Input current (all three phases, for each module).
3. Input frequency.
4. Battery voltage for each module.
5. Output frequency.
6. Output voltage (all three phases - system output).
7. Output current (all three phases - system output).
8. Output kilowatts (system output).

3.4 BATTERY DISCHARGE TEST

A. With the battery fully charged, the system shall undergo a complete battery discharge test to full depletion and a recharge to nominal conditions per manufacturers recommendations. This test shall be completed at full load rating of the UPS system. Instrument readings shall be recorded every minute during discharge for the following:

1. Battery voltage for each module
2. Battery current for each module
3. Output voltage (all three phases - system output)
4. Output current (all three phases - system output)
5. Output kilowatts (system output)
6. Output frequency

END OF SECTION 26 33 05

SECTION 26 36 00 - AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide automatic transfer switch(es) as shown on the drawings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Provide automatic transfer switch as manufactured by ASCO, Kohler, Zenith, Russelectric, or approved substitute.

2.2 EQUIPMENT

A. Switch shall be UL listed and CSA certified. It shall meet the voltage impulse withstand test in accordance with the proposed NEMA Standard ICS-109.21 and voltage surge withstand capability in accordance with ANSI C37.90A/IEEE 472. Switch(es) shall have ampere rating and voltage rating as shown on drawings.

B. Transfer switch(es) to be in NEMA-1 wall-mounted enclosures unless otherwise indicated. All control relays to be accessible from front of enclosure for maintenance and repair. Transfer mechanism to be electrically operated, mechanically held. Failure of the emergency source shall result in retransfer to the normal source. The transfer switch to be equipped with a manual operator to allow for manual transfer.

C. Engine starting contacts to be provided to start engine, should the voltage of the normal source drop below the preset value, after a time delay of 1-3 seconds to allow for momentary dips.

D. After restoration of normal power, transfer switch shall remain in emergency position for an adjustable period of 0-30 minutes (set for 15 minutes unless directed otherwise). After retransfer to normal, engine/generator to continue to run for an adjustable period of 0-20 minutes to allow for cool down. A voltage/frequency relay to be provided to prevent transfer to the emergency source until operating level is attained.

E. In addition to position indicating lamps, auxiliary contacts to be provided (one normally open, one normally closed).

F. Provide test switch to simulate a power failure, under load conditions.

G. Provide an automatic exerciser to operate the unit for a period of 30 minutes every 168 hours. During exercise period, transfer switch(es) shall not transfer to the emergency source.

H. Transfer switches used with ground-fault equipment, 4-wire systems to be 4-pole switched neutral or 3-pole with overlapping neutral contacts.

I. Switch(es) to be double throw actuated by a single operator, momentarily energized. Main contacts may be replaced without major disassembly. Transfer switch(es) with magnetic blow outs to be provided on each pole.

J. Normal voltage sensing to be on 3-phase with pick-up at 95 percent and drop-out at 90 percent of normal voltage.

K. Interlocked molded case circuit breakers, contactors or transfer devices with dual solenoid operators are not acceptable.

L. ATS shall be equipped with a transparent protective cover allowing visual inspection of contacts while inhibiting inadvertent contact with energized components.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Switch shall be installed as shown on the drawing complete with all controls for engine starting and transfer.

END OF SECTION 26 36 00

SECTION 26 43 00 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide 3-phase, 4-wire Surge Protective Devices (SPDs) as indicated on the panelboard schedules and on the riser diagram.

1.2 RELATED WORK

A. Section 26 24 16 - Panelboards.

B. Section 26 24 13 - Circuit Breaker Distribution Switchboard

C. Section 26 05 26 – Grounding and Bounding for Electrical Systems.

1.3 STANDARDS

A. UL compliance: Listed to UL 1449 4th Edition by an OSHA approved Nationally Recognized Test Lab (NRTL)

B. ANSI/IEEE compliance: Comply with ANSI/IEEE C62.1, C62.41, and C62.45 test procedures.

C. National Electric Code - Section 280 and 285.

D. UL96A, Para. 13.1

1.4 SUBMITTALS

A. Submit product data and shop drawings as required by Section 26 01 00.

B. Submittals shall include the following:

1. Complete manufacturers' data for each suppressor indicating part numbers and rated voltages and currents.
2. Product performance analysis with graphic display of let-thru waveforms and peak clamping voltages for ANSI C62.41 tests, Categories A3 & B3 ringwaves and C1 & C3 impulses.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. SPDs shall be as manufactured by Current Technology, EFI Corporation, Liebert, or approved equal.

B. The suppressor manufacturer shall offer factory repair service for all units, which will include replacement for non-repairable sealed units.

2.2 WARRANTY

A. SPD devices shall be warranted for a minimum of 10 years.

2.3 SPECIFICATIONS

A. General:

1. SPD shall be internally fused, capable of allowing the suppressor's maximum rated transient current to pass through the suppressor without fuse operation. SPD shall be listed as a Type1 SPD without the need for upstream over current protection for safe operation.
2. Proper operation of the suppressor elements on each phase shall be indicated by a normally-on LED or lamp. Also, normally closed contacts shall be used for remote annunciation of suppressor failure.
3. The SPD shall be compatible with the electrical system voltage, current, and distribution configuration.
4. The SPD maximum continuous operating voltage shall be 115% of the nominal RMS voltage with no degradation. The MCOV value shall be a tested value as outlined in UL1449 3rd Edition section 37 .7 .3. The MCOV shall not be a claimed value based solely on the MCOV of the surge component used in the design, nor based solely on the 115% over voltage test outlined in UL1449.
5. The SPD shall be sine-wave tracking to provide added protection against oscillatory transients, such as Category A and B Ringwaves.
6. Failure of the SPD shall not cause any disruption of power.

B. Service Entrance SPD Devices:

1. The SPD shall have a surge current capacity of 100,000 amps (8 x 20 microsec) minimum per mode.
2. SPD devices shall meet or exceed the following operating characteristics and ratings: (Series Ratings)
3. The SPD shall be a Type1 listed SPD per UL1449 3rd Edition.
4. The SPD shall meet the requirements of UL96A, Para. 13.1

5. The unit shall not have more than 10% deterioration or degradation of the UL1449, 3rd Edition Voltage Protection Rating (VPR) due to repeated surges. Acceptable clamping values are shown below based on test procedures outlined in UL1449 3rd Edition

System Voltage	Mode	MCOV	B3 Ringwave	C3 Comb. Wave	UL 1449 Second Edition SVR Rating	UL 1449 Third Edition VPR Rating
120/240	L-N	150	325/375	650/775	400/400	700/700
120/208	L-G	150	400/450	650/825	500/500	700/700
	N-G	0	350/350	500/500	500/500	900/1000
	L-L	300	400/500	950/1250	700/700	900/1000
277/480	L-N	320	550/600	1125/1225	800/800	900/1000
	L-G	320	850/875	1075/1225	1000/1000	1200/1200
	N-G	0	700/700	900/900	900/900	1200/1500
	L-L	550	650/750	1950/2200	1500/1500	1800/1800

C. Distribution Panel SPD Devices:

1. The SPD shall have a surge current capacity of 60,000 amps (8 x 20 microsec) minimum per mode.
2. SPD devices shall meet or exceed the following operating characteristics and ratings: (Series Ratings)
3. The SPD shall be a Type1 or Type2 SPD per UL1449 3rd Edition.
4. The unit shall not have more than 10% deterioration or degradation of the UL1449, 3rd Edition Voltage Protection Rating (VPR) due to repeated surges. Acceptable clamping values are shown below based on test procedures outlined in UL1449 3rd Edition.

System Voltage	Mode	B3 Ringwave	B3/C1 Comb. Wave	C3 Comb. Wave	UL 1449 Second Edition SVR Rating	UL 1449 Third Edition VPR Rating
120/240	L-N	420	642	1040	400	800
120/208	L-G	480	690	1300	400	800
	N-G	340	620	1240	400	800
	L-L	610	1010	1420	700	1200
277/480	L-N	660	910	1490	700	1200
	L-G	750	1068	1830	800	1200
	N-G	720	974	1690	800	1200
	L-L	960	1700	2290	1500	1800

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount all 3-phase SPD devices in a separate cabinet attached to the panelboard it serves. The SPD shall not be internally mounted to the power or distribution panelboard. Cabinets for devices serving large service entrance main switchboards shall be located in a section of the switchboard where this option is made available by the manufacturer or be externally mounted to the switchboard. Cabinets for devices serving flush-mounted panelboards shall also be suitable for flush mounting. Cabinets shall comply with Section 26 27 16 of the specifications.

B. Ground the SPDs and cabinets in accordance with the manufacturer's instructions, the National Electrical Code (section 280 and 285), and wiring diagrams shown on the drawings.

C. The SPD shall not include multiple replacement modules.

D. All conductors associated with SPDs shall be installed in conduit. Minimum conductor size shall be #8 AWG copper. Conductors shall be as short and as straight as possible with no unnecessary length or turns. A maximum length of 12 inches is required where possible.

E. SPDs shall be connected in parallel with main conductors. Service entrance SPDs shall incorporate the use of an internally mounted disconnect. Panelboard surge protectors shall be installed behind a minimum 60-amp overcurrent/disconnecting device. Where 12 inches of lead length is not possible utilization of a low impedance preassembled cable assembly is required to lower the clamping voltages of the installed system to acceptable levels. Lead length must include phase connection plus neutral or ground.

F. Mounting position of the SPD and overcurrent protection device shall be coordinated to minimize the total phase, neutral and ground cable lengths to achieve minimum installed system clamping voltages.

END OF SECTION 26 43 00

SECTION 26 51 00 - INTERIOR LIGHTING AND LAMPS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, material, equipment and services necessary to provide all interior lighting fixtures, necessary hangers and lamps. Fixtures include all interior fixtures plus all exterior fixtures mounted to exterior wall or to structures connected directly to building.

1.2 SUBMITTALS

A. Submit for approval prior to purchasing fixtures complete fixture lists of fixtures proposed to be used. Include cuts of both specified fixture and proposed equivalent fixtures if fixtures other than those specified are submitted.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Provide lighting fixtures indicated by type on lighting fixture schedule on drawings.

2.2 EQUIPMENT REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Standards:

1. ENERGY STAR certified.
2. California Title 24 compliant.
3. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
4. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
5. UL Listing: Listed for damp location.
6. Recessed luminaires shall comply with NEMA LE 4.
7. User Replaceable Lamps:

    a. Bulb shape complying with ANSI C78.79.
    b. Lamp base complying with ANSI C81.61.

C. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

D. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

E. Provide luminaires from a single manufacturer for each luminaire type.

F. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

G. Rated lamp life of 50,000 hours to L70.

H. Lamps dimmable from 100 percent to 0 percent of maximum light output.

I. Internal driver.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Comply with NECA1.

B. Fixtures shall be securely mounted as required by Section 410, NEC and as specified herein.

C. Fixtures mounted in a suspended ceiling shall be secured to the grid with approved clips as required by the NEC.

D. Fixtures shall be mounted in locations as shown on architectural reflected ceiling drawings.

E. Mount fixtures as called for in schedule on electrical drawings. Determine type of ceiling to be installed in each space from architectural drawings and schedules and furnish fixtures suitable for the exact type.

F. Receive, store, uncrate, and install lighting fixtures shown in schedule on drawings to be furnished by others.

G. Recessed fixtures in dropped ceiling areas shall be connected using Greenfield and No. 14 THHN wire. Greenfield shall be connected to fixture and outlet box. Each piece of Greenfield shall include in it a separate insulated green grounding conductor not smaller than No. 14 AWG for grounding continuity between fixture and conduit system. Grounding conductor shall be mechanically connected in a permanent and effective manner to fixture and conduit system and shall be electrical continuous. No conduit shall enter a recessed fixture directly as this would prevent removal of fixture without disturbing balance of circuit.

H. Joints in fixture wiring shall be made using wire nuts, preinsulated Scotch locks, Ideal No. 30-410 crimps and No. 30-415 wrap caps, or other approved mechanical means of connection.

I. Adjustable type fixtures shall be adjusted by the Contractor to illuminate intended area to satisfaction of Owner.

J. Any adjustable outside area lights or lights mounted on building shall be adjusted at night by the contractor to satisfaction of Owner.

K. Recessed fixtures installed in exposed or concealed tee bar ceilings may not use ceiling grid to support fixtures. Fixtures shall be securely fastened to ceiling framework per NEC Article 410, and shall be supported as described in seismic detail.

L. Surface or recessed fixtures in or on plastered or drywall ceilings shall be supported in accordance with seismic fixture mounting details and shall not depend on ceilings for support.

M. Support fixtures in seismic zones per detail on drawings.

N. All light fixtures shall be grounded in accordance with the NEC. Any fixtures suspended from ceiling which do not include a separate ground wire shall be grounded in a method approved by section 250 of the NEC. Where the conduit is utilized as the ground with a hook pendant style mounting system, a separate ground conductor shall be bonded to the conduit where the conduit ceases to be continuous and routed to the fixture.

END OF SECTION 26 51 00

SECTION 26 56 00 - EXTERIOR LIGHTING AND LAMPS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services necessary for installation of all exterior lighting fixtures, lamps, poles, pole bases etc. for:

1. Exterior signage.
2. Walkways and exterior building lights.

B. Refer to details and arrangements shown on drawings.

C. Provide concrete bases as required for type of arrangements indicated.

D. Concrete bases as required for type of arrangements indicated shall be installed under Division 03. Coordinate with other divisions for proper size of bases, anchor bolt arrangements, conduit stub-ups to pole bases, etc.

E. Fixtures, poles, and appurtenances, shall be suitable for exterior use, shall be UL listed, and shall be of standard design for intended application.

1.2 SUBMITTALS

A. Submit for approval prior to purchasing fixtures complete shop drawings and brochures including photometrics for each type of exterior lighting system specified. Shop drawings and brochures shall be specific and shall include all pertinent data and accessories. If substitute fixtures are proposed, include cuts of both specified fixture and proposed equivalent fixtures including photometrics of both fixtures.

B. If requested by Architect, submit a sample fixture which will be returned after inspection by Architect.

C. Architect reserves right to accept any fixture as an approved equivalent.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Lighting fixtures as indicated on Lighting Fixture Schedule.

B. Contactors and selector switches shall be Square D or approved substitute.

C. Photocells: Tork.

D. Lighting Contactors: Square D or approved substitute.

2.2 MATERIALS

A. Provide luminaire and pole assemblies as scheduled.

B. Luminaires, including all components, shall be designed to meet extreme temperature (low), moisture, and wind conditions in area.

C. Poles: Steel round or square, designed for wind load in the area of installation.

D. All 150-1500 watt metal halide luminaires shall be equipped with a proper ballast that is in compliance with the minimum requirements of the Energy Independence and Security Act of 2007 (EISA of 2007). Luminaires shall be marked with the circle E symbol indicating compliance with EISA.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install parking lot/roadway luminaires and poles on concrete bases. Provide all anchor bolts and bolt hole circle templates. Adjust luminaires to correct tilt and lamp all fixtures.

B. Adjust or rotate area and roadway lighting at night to maximize light utilization in intended areas.

C. Install large area luminaires and poles on concrete bases. Provide all anchor bolts and bolt hole circle templates. Adjust luminaires to correct tilt and lamp all fixtures.

D. Install high mast luminaires and poles on concrete bases. Provide all anchor bolts and bolt hole circle templates. Adjust luminaires as required and lamp all fixtures.

E. Contractor to adjust or rotate area and roadway lighting at night to maximize light utilization in intended areas.

F. Bond together ground connections of luminaires to equipment grounding conductor, pole, and if present, separate 3/4" diameter x 10' copperweld ground rod driven at base of each pole.

G. Ground all luminaires to poles and all poles to equipment grounding conductor or to separate 3/4" diameter x 10' copperweld ground rod driven at base of each pole.

H. Each pole mounted outside lighting luminaire shall have its conductors spliced to the branch circuit connectors in the pole base. Provide a Tron waterproof fuse holder with time delay fuse (1.5 X luminaire current) in the pole base for each ungrounded conductor for each luminaire.

END OF SECTION 26 56 00

SECTION 28 31 00 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SCOPE AND RELATED DOCUMENTS

A. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performance of all operations associated with the installation of the fire alarm system as shown on the drawings and as herein specified.

B. The requirements of the conditions of the Contract, Supplementary Conditions, and General Requirements apply to the work specified in this section.

C. The complete installation shall conform to the applicable sections of NFPA-72, local code requirements, and National Electrical Code with particular attention to Article 760.

D. The work covered by this section of the specifications shall be coordinated with the related work as specified elsewhere under the project specifications.

1.2 QUALITY ASSURANCE

A. Each and all items of the fire alarm system shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the UL label. All control equipment shall be listed under UL category UOJZ as a single control unit. Partial listing shall not be acceptable.

B. All control equipment must have transient protection to comply with UL864 requirements.

C. Where fire alarm circuits leave the building, additional transient protection must be provided for each circuit. Devices must be UL listed under Standard 497B, Isolated Loop Circuit Protectors.

1.3 GENERAL

A. Furnish and install a complete fire alarm system as described herein and as shown on the plans, to be wired, connected, and left in first class operating condition. Include sufficient control panel(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, alarm indicating appliances, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.

1. The fire alarm system shall allow for loading and editing special instructions and operating sequences as required. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control panel. Loss of primary and secondary power shall not erase the instructions stored in memory.
2. Full flexibility for selective input/output control functions based on anding, oring, noting, timing, and special coded operations shall also be incorporated in the resident software programming of the system.

B. Resident software shall allow for full configuration of initiating circuits so that additional hardware shall not be necessary to accommodate changes in, for instance, sensing of normally open contact devices to sensing of normally closed contact devices, or from sensing of normally open contact devices to sensing a combination of current limited and non-current limited devices on the same circuit and being able to differentiate between the two, or changing from a non-verification circuit to a verification circuit or vice-versa.

C. Resident software shall also allow for configuration of indicating appliance and control circuits so that additional hardware shall not be necessary to accommodate changes in, for instance, changing a non-coded indicating appliance circuit to a coded circuit, or from a slow march time (20 BPM) to a fast march time (120 BPM).

D. The system shall have the capability of recalling alarms and trouble conditions in chronological order for the purpose of recreating an event history.

E. All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name on each component. The catalog numbers specified under this section are those of Simplex Time Recorder Company and constitute the type, product quality, material, and desired operating features.

F. If equipment of another manufacturer is submitted for approval, the contractor shall state how much is to be deducted from his base bid for the substitution, and also shall state what, if any, specific points of system operation differ from the specified points of the system operation. This differentiation report must reference every paragraph of this specification.

1.4 OPERATION

A. The system alarm operation subsequent to the alarm activation of any manual station, automatic detection device, or sprinkler flow switch shall be as follows:

1. All audible alarm indicating appliances shall:

a. Sound a continuous fire alarm signal until silenced by the alarm silence switch at the control panel.

b. Sound a selective positive non-interfering successive zone code. Interference of this code shall not be permitted until a completed transmission of its assigned number of rounds. Should coding be completed, a continuous master code or march time pattern shall sound until silenced by the alarm silence switch at the control panel
c. Sound a march time pattern until silenced by the alarm silence switch at the control panel.
d. Sound a master code until silenced by the alarm silence switch at the control panel. The master code will consist of a common code, e.g., 4-4-4.

2. All visible alarm indicating appliances shall flash continuously until the system is reset.
3. Alarm indicating appliances shall operate selectively by zone.
4. The audible alarms shall be automatically silenced after 15 minutes of alarm operation.
5. The audible alarms shall be inhibited from being silenced for a period of 3 minute(s) after commencing operation.
6. Any subsequent zone alarm shall reactivate the alarm indicating appliances.
7. All doors normally held open by door control devices shall release after a 10 second time delay.
8. A supervised signal to notify an approved central station shall be activated.
9. The mechanical controls shall activate the air handling systems in accordance with NFPA 90.

B. Upon reset of the fire alarm control panel, air handling units shall sequentially start up to minimize power demand.

C. The alarm shall be displayed on an 80 character LCD display. The top line of 40 characters shall be the point label and the second line shall be the device type identifier. The system alarm LED shall flash on the control panel until the alarm has been acknowledged. Once acknowledged, this same LED shall latch on. A subsequent alarm received from another zone shall flash the system alarm LED on the control panel. The LCD display shall show the new alarm information.

D. A pulsing alarm tone shall occur within the control panel until the event has been acknowledged.

E. The alarm activation of any elevator lobby smoke detector shall, in addition to the operations listed above, cause the elevator cabs to be recalled according to the following sequence:

1. If the alarmed detector is on any floor other than the main level of egress, the elevator cabs shall be recalled to the main level of egress.
2. If the alarmed detector is on the main egress level, the elevator cabs shall be recalled to the predetermined alternate recall level as determined by the local authority having jurisdiction.

F. The activation of any system smoke detector shall initiate an alarm verification operation whereby the panel will reset the activated detector and wait for a second alarm activation. If, within one (1) minute after resetting, a second alarm is reported from the same or any other smoke detector, the system shall process the alarm as described previously. If no second alarm occurs within one minute, the system shall resume normal operation. The alarm verification shall operate only on smoke detector alarms. Other activated initiating devices shall be processed immediately. The alarm verification operation shall be selectable by zone.

1. The control panel shall have the capability to display the number of times (tally) a zone has gone into a verification mode. Should this smoke verification tally reach a pre-programmed number, a trouble condition shall occur.

G. The control panel shall have a dedicated supervisory service LED and a dedicated supervisory service acknowledge switch.

1. The activation of any standpipe or sprinkler valve supervisory (tamper) switch shall activate the system supervisory service audible signal and illuminate the LED at the control panel. Differentiation between valve tamper activation and opens and/or grounds on the initiation circuit wiring shall be provided.
2. Pressing the supervisory service acknowledge key will silence the supervisory audible signal while maintaining the supervisory service LED "ON" indicating the off-normal condition.
3. Restoring the valve to the normal position shall cause the supervisory service LED to extinguish, indicating restoration to normal.

H. The alarm activation by either a manual or an electrically operated coded station shall pulse the alarm indicating appliance to follow that code. The coded input signal shall take priority over all other input signals. All other alarm inputs shall be processed accordingly after coding is completed. If PNIS code is interrupted, it must be restarted and completed in its entirety without missing any portion of the code. Activation of control circuits for door release and air handling system shall not be delayed.

I. A manual evacuation (drill) switch shall be provided to operate the alarm indicating appliances without causing other control circuits to be activated. However, should a true alarm occur, all alarm functions would occur as described previously.

J. The system shall have a single key that will allow the operator to display all alarms, troubles, and supervisory service conditions including the time of each occurrence.

K. All doors normally held open by door control devices shall release upon AC power failure.

L. The actuation of the "enable walk test" program at the control panel shall activate the "walk test" mode of the system which shall cause the following to occur:

1. The city circuit connection shall be bypassed.
2. Control relay functions shall be bypassed.
3. The control panel shall show a trouble condition.
4. The alarm activation of any initiation device shall cause the audible signals to activate for two seconds.
5. The panel shall automatically reset itself after signaling is complete.
6. Any momentary opening of an initiating or indicating appliance circuit wiring shall cause the audible signals to sound for four seconds indicating a trouble condition.

1.5 SUPERVISION

A. The system shall contain Class "B", Style "B" independently supervised initiating device circuits. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.

B. There shall be supervisory service initiation device circuits for connection of all sprinkler valve supervisory (tamper). Device activation shall cause a supervisory alarm at the control panel.

C. There shall be 4 independently supervised and independently fused indicating appliance circuits for alarm horn strobes. Disarrangement conditions of any circuit shall not affect the operation of other circuits.

D. Auxiliary manual controls shall be supervised so that an "off normal" position of any switch shall cause an "off normal" system trouble.

E. Each independently supervised circuit shall include a discrete LCD readout to indicate disarrangement conditions per circuit.

F. The incoming power to the system shall be supervised so that any power failure must be audibly and visually indicated at the control panel. A green "power on" LED shall be displayed continuously while incoming power is present.

G. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the control panel.

H. The system modules shall be electrically supervised for module placement. Should a module become disconnected, the system trouble indicator shall illuminate and the audible trouble signal shall sound.

I. The system shall have provisions for disabling and enabling all circuits individually for maintenance or testing purposes.

J. There shall be independent supervision for opens of the air handling on/off/auto switch control output wiring. A discrete trouble LCD readout per output circuit will be provided for indication. A ground condition of the air handling control output wiring shall indicate a common ground trouble on the control panel.

1.6 POWER REQUIREMENTS

A. The control panel shall receive 120 VAC power (as noted on the plans) via a dedicated fused disconnect circuit.

B. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of twenty-four (24) hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic.

C. All external circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control panel.

PART 2 - PRODUCTS

2.1 FIRE ALARM CONTROL PANEL - SIMPLEX TYPE 4100-8001

A. Control panel construction shall be modular with solid-state, microprocessor-based electronics. It shall display only those primary controls and displays essential to operation during a fire alarm condition. Keyboards or keypads shall not be required to operate the system during fire alarm conditions.

1. A local audible device shall sound during alarm, trouble, or supervisory conditions. This audible device shall sound differently during each condition to distinguish one condition from another without having to view the panel. This audible device shall also sound during each keypress to provide an audible feedback to ensure that the key has been pressed properly.

B. The following primary controls shall be visible through a front access panel:

1. Eighty character liquid crystal display.
2. Individual red system alarm LED.
3. Individual yellow supervisory service LED.
4. Individual yellow trouble LED.
5. Green "power on" LED.
6. Alarm Acknowledge key.
7. Supervisory Acknowledge key.
8. Trouble Acknowledge key.
9. Alarm Silence key.
10. System Reset key.

C. The following secondary control switches and LEDs shall be available behind an access door:

1. City disconnect/switch.
2. Manual evacuation (drill).
3. Elevator bypass.
4. Door holder release bypass.

5. Future.

D. The control panel shall provide the following:

1. Setting of time and date.
2. LED testing.
3. Alarm, Trouble, and Abnormal condition listing.
4. Enabling and disabling of each monitor point separately.
5. Activation and deactivation of each control point separately.
6. Changing operator access levels.
7. Walk Test enable.
8. Running diagnostic functions.
9. Displaying software revision level.
10. Displaying historical logs.
11. Displaying card status.
12. Point listing.

E. For maintenance purposes, the following lists shall be available from the point lists menu:

1. All points list by address.
2. Monitor point list.
3. Signal/speaker list.
4. Auxiliary control list.
5. Feedback point list.
6. Psuedo point list.
7. LED/switch status list.

F. Scrolling through menu options or lists shall be accomplished in a self-directing manner in which prompting messages shall direct the user. These controls shall be located behind an access door.

G. Primary Keys, LEDs, and LCD Display:

1. The control panel shall have a 2 line x 40 character liquid crystal display which shall be backlit for enhanced readability. So as to conserve battery standby power, it shall not be lit during an AC power failure unless an alarm condition occurs or there is keypad activity.
2. The display shall support both upper and lower case letters. Lowercase letters shall be used for softkey titles and prompting the user. Uppercase letters shall be used for system status information. A cursor shall be visible when entering information.

2.2 SYSTEM FRONT PANEL OPERATION AND CAPABILITIES

A. Under normal condition, the front panel shall display a "System is Normal" message and the current time and date.

B. Should an abnormal condition be detected, the appropriate LED (Alarm, Supervisory, or Trouble) shall flash. The panel audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

C. The LCD shall display the following information relative to the abnormal condition of a point in the system.

1. 40 character custom location label.
2. Type of device (i.e., smoke, pull station, water flow).
3. Point status (i.e., alarm, trouble).

D. Two methods of acknowledgment for each abnormal condition shall be provided. One may be chosen depending on the NFPA requirements.

1. For NFPA 72D requirements: Pressing the appropriate acknowledge button shall display the first unacknowledged condition in the appropriate list (either alarm, supervisory, or trouble), and require another acknowledge button. Press to acknowledge only the displayed point.
2. For NFPA 72A, B, or C requirements: Pressing the appropriate acknowledge button shall globally acknowledge every point in the list.

E. These acknowledge functions may be passcode protected if the user has insufficient privilege to acknowledge such conditions. A message shall indicate insufficient privilege but allow the user to view the points without acknowledging them. Should the user have sufficient privilege to acknowledge, a message will be displayed informing the user that the condition has been acknowledged.

F. After all points have been acknowledged, the LEDs shall glow steady and the Sonalert will be silenced. The total number of alarms, supervisory, and trouble conditions shall be displayed along with a prompt to review each list chronologically. The end of the list shall be indicated by an end-of-list message "END OF LIST."

G. Alarm Silencing:

1. Should the Alarm Silence button be pressed, all audible alarm signals shall cease to operate.
2. Signals shall not be silenced during alarm silence inhibit mode.

H. System Reset:

1. The System Reset button shall be used to return the system to its normal state after an alarm condition has been remedied. The LCD display shall step the user through the reset process with simple English Language messages. Messages "SYSTEM RESET IN PROGRESS" will first be displayed followed by the message "SYSTEM RESET COMPLETED" and finally "SYSTEM IS NORMAL" should all alarm conditions be cleared.

2. Should an alarm condition continue to exist the message "SYSTEM RESET IN PROGRESS" will be followed by the message "SYSTEM RESET ABORTED" and the system will remain in an abnormal state. System control relays shall not reset. The Sonalert and the alarm LED will be on. The display will indicate the total number of alarms and troubles present in the system along with a prompt to use the ACK keys to review the points. These points will not require acknowledgment, if they were previously acknowledged.
3. Should the Alarm Silence Inhibit function be active, the SYSTEM RESET key press will be ignored. The message "SYSTEM RESET INHIBITED" will be displayed for a short time to indicate the action was not taken. As feedback to the operator, the message "SYSTEM RESET NO LONGER INHIBITED" will be displayed when the inhibit function times out.

I. Function Keys:

1. Additional function keys shall be provided to access status data for the following points:

   a. Initiating device circuits.
   b. Indicating appliance circuits.
   c. Auxiliary relays.
   d. Feedback points.
   e. All other input/output points.

2. The following status data shall be available.

   a. Primary state of point.
   b. Zone, PID and Card type information.
   c. Class "A" status.
   d. Current priority of outputs.
   e. Disable/Enable status.
   f. Verification tallies of initiating devices.
   g. Automatic/Manual Control Status of output points.
   h. Acknowledge status.
   i. Relay status.

J. History Logging:

1. The system shall be capable of logging and storing 300 events in an alarm log and 300 events in a trouble log. These events shall be stored in a battery-protected random access memory. Each recorded event shall include the time and date of that event's occurrence.
2. The following Historical Alarm log events shall be stored:

   a. Alarms.
   b. Alarm Acknowledgment.
   c. Alarm Silence.
   d. System Reset.
   e. Alarm Historical log cleared.

3. The following Historical Trouble log events shall be stored:

    a. Trouble conditions.
    b. Supervisory alarms.
    c. Trouble acknowledgment.
    d. Supervisory acknowledgment.
    e. Alarm Verification tallies.
    f. Walk Test results.
    g. Trouble Historical log cleared.

4. Silent Walk Test with History Logging:

    a. The system shall be capable of being tested by one person. While in testing mode, the alarm activation of an initiating device circuit shall be silently logged as an alarm condition in the historical data file. The panel shall automatically reset itself after logging of the alarm.
    b. The momentary disconnection of an initiating or indicating device circuit shall be silently logged as a trouble condition in the historical data file. The panel shall automatically reset itself after logging of the trouble condition.
    c. Should the walk test feature be on for an inappropriate amount of time, it shall revert to the normal mode automatically.
    d. The control panel shall be capable of supporting up to 8 separate testing groups whereby one group of points may be in a testing mode and the other (non-testing) groups may be active and operate as programmed per normal system operation. After testing is considered complete, testing data may be retrieved from the system in chronological order to ensure device/circuit activation.
    e. Should an alarm condition occur from an active point, not in walk test mode, it shall perform operations described in Section 1.4.

K. LED Supervision: All slave module LEDs shall be supervised for burnout or disarrangement. Should a problem occur, the LCD shall display the module and LED location numbers to facilitate location of that LED.

L. System Trouble Reminder: Should a trouble condition be present within the system and the audible trouble signal silenced, the trouble signal shall resound at preprogrammed time intervals to act as reminder that the fire alarm system is not 100% operational. Both the time interval and the trouble reminder signal shall be programmed to suit the owner's application.

M. Access Levels:

1. There shall be four (4) access levels with level 4 being the highest level. Level 1 actions shall not require a passcode. Passcodes shall consist of up to ten (10) digits. Changes to passcodes shall only be made by authorized personnel.

2. In order to maintain security when entering a passcode, the digits entered will not be displayed, but a cursor will move along filling the position with an X to indicate that the digit has been accepted. All key presses will be acknowledged by a local audible sound.
3. When a correct passcode is entered, the message "Access Granted" shall be displayed. The new access level shall be in effect until the operator manually logs out or the keypad has been inactive for ten (10) minutes.
4. Should an invalid code be inputted, the operator shall be notified with the message "ERROR...INCORRECT PASSCODE" and shall be allowed up to three chances to enter a valid code. After three unsuccessful tries, the message "ACCESS DENIED" shall be displayed. The level shall not be altered, and the operator shall no longer be in the menu option.
5. Access to a level will only allow the operator to perform all actions within that level plus all actions of lower levels, not higher levels.
6. The following keys/switches shall have access levels associated with them:

    a. Alarm Silence
    b. System Reset
    c. Set Time/Date
    d. Manual Control
    e. On/Off/Auto Control
    f. Disable/Enable
    g. Clear Historical Alarm Log
    h. Clear Historical Trouble Log
    i. Walk Test
    j. Change Alarm Verification

7. Acknowledge keys shall also require privileged access to acknowledge points. If the operator presses an (ACK) key with insufficient access, an error message will be displayed. The points will scroll with (ACK) key presses to view the points on the list, but the points will not get acknowledged in the database.

N. Equipment Enclosures: Provide cabinets of sufficient size to accommodate the aforementioned equipment. Cabinet shall be equipped with locks and transparent door panel providing freedom from tampering yet allowing full view of the various lights and controls.

2.3 MULTIPLE ADDRESSABLE PERIPHERAL NETWORK (MAPNET)

A. Communication with addressable devices. The system must provide communication with initiating and control devices individually. All of these devices will be individually annunciated at the control panel. Annunciation shall include the following conditions for each point:

1. Alarm.
2. Trouble.
3. Open.
4. Short.

5. Device missing/failed.

B. All addressable devices shall have the capability of being disabled or enabled individually.

C. Up to 127 addressable devices may be multi-dropped from a single pair of wires. Systems that require factory reprogramming to add or delete devices are unacceptable.

D. Format: The communication format must be a completely digital poll/response protocol to allow t-tapping of the circuit wiring. A high degree of communication reliability must be obtained by using parity data bit error checking routines for address codes and check sum routines for the data transmission portion of the protocol. Systems that do not utilize full digital transmission protocol are not acceptable.

E. Identification of Addressable Devices: Each addressable device must be uniquely identified by an address code entered on each device at time of installation. The use of jumpers to set address will not be acceptable due to the potential of vibration and poor contact. Device identification schemes that do not use uniquely set addresses, but rely on electrical position along the communication channel are unacceptable. These systems cannot accommodate t-tapping the addition of an addressable device between existing devices requires reprogramming all existing electrically further devices. The system must verify that proper type device is in place and matches the desired software configuration.

F. Wiring Type, Distances, Survivability, and Configurations: Wiring types will be approved by the equipment manufacturer. Existing wiring will be utilized in retrofit applications. The system shall allow a line distance of up to 2,500 feet to the furthest addressable device on a Class B circuit. (Class A communications will be provided where shown on the drawings. Wire will be so routed to maintain sufficient distance between the forward and return loop as called for by the authority having jurisdiction.) To minimize wire routing and to facilitate future additions, t-tapping of the communications channel will be supported except where Class A wiring is required.

G. Addressable Device Types:

1. General: The system control panel, must be capable of communicating with the types of addressable devices specified below. The location of addressable devices will be selected along with conventional devices to optimize the system layout in order to provide the level of protection, zone identification, and control as shown on the drawings.

2. TrueAlarm Addressable Detector Bases - Simplex Type 4098-9781: All addressable smoke and heat detector heads as specified below will be pluggable into their bases. The base will contain electronics that communicate the detector status (normal, alarm, trouble) to the control panel over two wires. The same two wires shall also provide power to the base and detector. Different detector heads (smoke or heat) must be interchangeable. Upon removal of the head, a trouble signal will be transmitted to the control panel.
3. Ionization Detector Heads - Simplex Type 4098-9716, TrueAlarm:

    a. The ionization type detector shall be a plug-in unit which mounts to a twist-lock base and shall be UL listed.
    b. In order to provide stability over wide changes in environmental conditions such as temperature, humidity and pressure, they will be of dual chamber type: one chamber for sampling, one chamber for reference. They will be sealed against rear airflow entry.
    c. There shall be no limit to the number of detectors, stations, or zone adapter modules, which may be activated or "in alarm" simultaneously.
    d. The detector shall fit into a base that is common with both the heat detector and photoelectric type detector and shall be compatible with other addressable detectors, addressable manual stations, and addressable zone adapter modules on the same circuit. The detector shall also fit into a non-addressable base that is capable of being monitored by an addressable zone adapter module.
    e. Cover all smoke detection devices with plastic bags immediately after installation to maintain cleanliness, if field conditions so require.

4. Photoelectric TrueAlarm Sensor - Simplex Type 4098-9701:

    a. The photoelectric type detector shall be a plug-in unit which mounts to a twist-lock base, and shall be UL approved.
    b. The detectors shall be of the solid-state photoelectric type and shall contain no radioactive material. They will use a pulsed infrared LED light source and be sealed against rear airflow entry.
    c. The detector shall fit into a base that is common with both the heat detector and ionization type detector and shall be compatible with other addressable detectors, addressable manual stations, and addressable zone adapter modules on the same circuit. There shall be no limit to the number of detectors or zone adapter modules which may be activated or "in alarm" simultaneously.

5. Addressable Thermal Detector Head - Simplex 4098-9731: Thermal detector heads must be UL listed. They will be a combination rate-of-rise and fixed temperature (135 F) type, automatically restorable.
6. Addressable Pull Stations - Simplex Type 2099-9784:

a. Addressable pull stations will contain electronics that communicate the station's status (alarm, normal) to the transponder over two wires which also provide power to the pull station. The address will be set on the station. They will be manufactured from high impact red Lexan. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common to all system locks. Pull stations will be double action.
b. The front of the station is to be hinged to a backplate assembly and must be opened with a key to reset the station. The key shall be common with the control panels. Stations which use Allen wrenches or special tools to reset, will not be accepted. The station shall consist of high impact Lexan plastic, red in color.
c. The addressable manual station shall be capable of field programming of its "address" location on an addressable initiating circuit. The manual station shall be fitted with screw terminals for field wire attachment.
d. There shall be no limit to the number of stations, detectors or zone adapter modules, which may be activated or "in alarm" simultaneously.
e. The addressable manual station shall be UL listed.

7. Addressable Photoelectric Duct Detector TrueAlarm - Simplex Type 4098-9702 with 4098-9701 Smoke Sensor:

a. The detector shall be a non-polarized 24 VDC type which is compatible with the fire alarm panel and obtains its operating power from the supervisory current in the fire alarm detection loop.
b. Detectors shall be of the solid-state photoelectric type and shall operate on the light scattering, photodiode principle. To minimize nuisance alarms, detectors shall have an insect screen and be designed to ignore invisible airborne particles or smoke densities that are below the factory set alarm point. No radioactive material shall be used.
c. The detector head shall be directly interchangeable with an ionization detector type. The 24 VDC detector may be reset by actuating the control panel reset switch.
d. Detector construction shall have a mounting base with a twist-lock detecting head that is lockable. The locking feature must be field removable when not required. Contact between the base and head shall be of the bifurcated type utilizing spring type, self-wiping contacts. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control panel. Detector design shall provide compatibility with other normally open fire alarm detection loop devices (heat detectors, pull stations, etc.).
e. It shall be possible to alarm the duct housing by using a test switch. Simplex Type 2098-9786 test LED alarm indicator.
f. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housings front cover.

g. To minimize false alarms, voltage and RF transient suppression techniques shall be employed as-well-as smoke signal verification circuit and an insect screen.
h. Auxiliary SPDT relays and or remote LED alarm indicators and key-operated test stations shall be installed where indicated.

8. Zone Adaptor Module - Simplex Type MAPNET II 2190-9155: Zone adapter modules shall be used for monitoring of water flow, valve tamper, Halon control panels, non-addressable detectors, and for control of evacuation indicating appliances and AHU systems:

a. An addressable interface module shall be provided for interfacing normally open direct contact devices to an addressable initiating circuit. The device shall be a Simplex Type Zone Adapter Module (ZAM).
b. ZAMs will be capable of mounting in a standard electric outlet box. ZAMs will include cover plates to allow surface or flush mounting. ZAMs will receive their 24 VDC power from a separate two-wire pair running from an appropriate power supply.
c. There shall be two types of devices:
d. For Type 1 above:

1) For conventional 2-wire smoke detector and/or contact device monitoring with class B or class A wiring supervision.

a) This type of addressable device module will provide power to and monitor the status of a zone consisting of conventional 2-wire smoke detectors and/or N/O contact devices as specified elsewhere The supervision of the zone wiring will be Class B. These ZAMs will communicate the zone's status (normal, alarm, trouble) to the transponder.

2) For conventional 4-wire smoke detector with Class B wiring supervision - 2190-9158.

a) This type of addressable device will provide power to and monitor the contact status of a zone consisting of conventional 4-wire smoke detectors as specified else. The ZAM will provide detector reset capability and a 2-amp fuse to provide over-current power protection for the 4-wire detector. These ZAMs will communicate the zone's status (normal, alarm, trouble) to the transponder.

e. For Type 2 above:

1) Zone Adaptor Module - Simplex Type 2190-9161.

a) For signals, speakers, fire fighter phone jacks and other device control with Class B or Class A wiring supervision.

b) This type of addressable device will provide double-pole, double-throw relay switching that can be used to connect through easily replaceable 2-amp fuses: a zone of signals to a power source, speakers to an audio source, fire fighter phone jacks to a communications channel, or activate a variety of controlled devices. The module will be available in either a Class B or Class A supervision version. In the Class B version, the wiring will be supervised by an end-of-line device. In the Class A version, the wiring will be looped back and connected to the module to allow continual operation of the controlled devices even if the wiring sustains a single break. Class B devices will be provided. These ZAMs will communicate the supervised wiring status (normal, trouble) to the fire alarm control panel and will receive a command to transfer the relay from the fire alarm control panel.

2) Zone Adaptor Module. For non-supervised control - Simplex Type 2190-9163. This type of addressable device will provide double-pole, double-throw relay switching for loads up to 120 VAC. It will contain easily replaceable 2-amp fuses, one on each common leg of the relay.

f. The ZAM shall be supervised and uniquely identified by the control panel. Device identification shall be transmitted to the control panel for processing according to the program instructions. Should the ZAM become non-operational, tampered with, or removed, a discrete trouble signal, unique to the device, shall be transmitted to, and annunciated at, the control panel.

g. The ZAM shall be capable of being programmed for its "address" location on the addressable device initiating circuit. The ZAM shall be compatible with addressable manual stations and addressable detectors on the same addressable initiating circuit.

9. Addressable Device Supervision:

a. All devices shall be supervised for trouble conditions. The system control panel will be capable of displaying the type of trouble condition (open, short, device missing/failed).

b. Should a device fail, it will not hinder the operation of other system devices.

H. Alarm Signals:

1. Provide audio/visual units with flush trims and backboxes for all wall mount audio-visual unit locations as shown on the plans.

2. Provide speakers with mounting plates for all locations requiring surface-mounted audio devices only.
3. Provide speakers and visual alarm signals for all locations requiring ceiling-mounted audio-visual alarm signals as shown on the plans.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be installed in strict compliance with all the provisions of NEC article 760 A and C, Power-Limited Fire Protective Signaling Circuits or if required may be reclassified as non-power limited and wired in accordance with NEC-Article 760 A and B. Upon completion, the contractor shall so certify in writing to the owner and general contractor.

1. All junction boxes shall be sprayed red and labeled "Fire Alarm." Wiring color code shall be maintained throughout the installation.

B. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.

C. The contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation.

D. The manufacturer's authorized representative shall provide on-site supervision of installation.

E. All wiring shall be installed in red conduit.

3.2 TESTING

A. The completed fire alarm system shall be fully tested in accordance with NFPA-72 by the contractor in the presence of the owner's representative and the local Fire Marshal. Upon completion of a successful test, the contractor shall so certify in writing to the owner and general contractor.

3.3 WARRANTY

A. The contractor shall warrant the completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one (1) year from the date of the completed and certified test or from the date of first beneficial use.

B. The equipment manufacturer shall make available to the owner a maintenance contract proposal to provide required inspections and tests per year in compliance with NFPA-72, Chapter 14 guidelines.

END OF SECTION 28 31 00

SECTION 33 77 30 - MEDIUM VOLTAGE METAL CLAD SWITCHGEAR

PART 1 - GENERAL

1.1 WORK INCLUDED

A. All work specified in this section shall comply with the provisions of Section 26 01 00.

B. Furnish and install metal-clad switchgear as described in this specification and as detailed on the plan sheets. This specification is written for 34.5kV switchgear lineups. Refer to information as denoted on one-line drawings.

C. The contractor shall be responsible for the erection, installation and start-up of the equipment covered by the specifications and plans.

D. The metal-clad switchgear and all components shall be designed, manufactured, and tested in accordance with the latest applicable standards of ANSI, NEMA and IEEE including, but not limited to, ANSI 37.20, NEMA SG-4 and SG-5.

1.2 SUBMITTALS - FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Designer, in addition to those items required in General Provisions.

1. Master drawing index.
2. Front view elevation.
3. Floor plan.
4. Top view.
5. Single line.
6. Schematic diagram.
7. Nameplate schedule.
8. Component list.
9. Conduit entry/exit locations.
10. Assembly ratings including:

    a. Short circuit rating.
    b. Voltage.
    c. Continuous current.
    d. Basic Impulse level for equipment over 600 volts.

11. Major component ratings including:

    a. Voltage.
    b. Continuous current.
    c. Interrupting ratings.

12. Cable terminal sizes.

B. Where applicable, the following additional information shall be submitted to the Designer.

1. Busway connection.
2. Connection details between close-coupled assemblies.
3. Composite floor plan of close-coupled assemblies.
4. Key interlock scheme drawing and sequence of operations.

1.3 SUBMITTALS - FOR INFORMATION

A. The following product information shall also be submitted:

1. Descriptive bulletins.
2. Product sheets.

1.4 SUBMITTALS - FOR CLOSEOUT

A. The following information shall be submitted for record purposes prior to final payment.

1. Final as-built drawings and information for items listed in Section 1.2.
2. Wiring diagrams.
3. Certified production test reports.
4. Installation information including equipment anchorage provisions.
5. Seismic certification if necessary.

1.5 QUALIFICATIONS

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

B. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. An acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. Provide Seismic tested equipment as follows:

1. Risk Category: II
2. Seismic Design Category: D
3. Seismic Importance Factor, I: 1.0
4. Mapped Spectral Response Accelerations: Ss = 0.945g, S1 = 0.331g
5. Spectral Response Coefficient: Sds = 0.707g
6. Fa = 1.122g, Fv = 1.739g, Sms = 1.061g, Sm1 = 0.575g

E. Guidelines for the installation consistent with these requirements to be provided by the switchgear manufacturer and be based upon testing of representative equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide equipment by the following or approved substitute:

1. General Electric / ABB
2. Eaton
3. Siemens
4. Schneider Electric
5. LS Electric

2.2 BREAKER ASSEMBLY

A. The switchgear described in this specification shall be designed for operation on a 34.5kV 3-phase, 3-wire, 60 hertz system.

B. Each circuit breaker shall have the following ratings:

1. As indicated on one-line drawings

C. Each circuit breaker shall have the following continuous current rating:

1. as indicated on one-line drawings

2.3 CONSTRUCTION

A. The switchgear assembly shall consist of individual vertical sections for housing various combinations of circuit breakers and auxiliaries, bolted to form a rigid metal-clad switchgear assembly. Metal side sheets shall provide grounded barriers between adjacent structures and solid removable metal barriers shall isolate the major primary sections of each circuit. Two rear covers shall be furnished for each vertical section for circuit isolation and ease of handling.

B. The stationary primary contacts shall be silver-plated and recessed within insulating tubes. A steel shutter shall automatically cover the stationary primary disconnecting contacts when the breaker is in the disconnected position of out of the cell. Provide rails to allow withdrawal of each circuit breaker for inspection and maintenance without the use of a separate lifting device.

C. Provide transition sections as required.

2.4 BUS

A. The main bus shall be copper and have fluidized bed epoxy flame retardant and track-resistant insulation. The bus supports between units shall be flame-retardant, track-resistant, glass polyester. The switchgear shall be constructed so that all buses, bus supports, and connections shall withstand stresses that would be produced by currents equal to the momentary ratings of the circuit breakers. A insulated copper main bus shall be provided and have provisions for future extension, bus shall be rated as shown on drawings. All bus joints shall be plated, bolted, and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to the close and latch rating of the breakers. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests.

B. A copper ground bus shall extend the entire length of the switchgear.

C. Cable connections between switchgear sections are not allowed.

2.5 WIRING/TERMINATIONS

A. The switchgear manufacturer shall provide suitable terminal blocks for secondary wire terminations, and a minimum of 10% spare terminal connections shall be provided. One control circuit cutout device shall be provided in each circuit breaker housing. Switchgear secondary wire shall be #14 AWG, type SIS rated 600-volt, 90 degrees C, furnished with wire markers at each termination. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.

B. Incoming line cable lugs of the type and size indicated elsewhere shall be furnished.

C. Each incoming line compartment shall have one medium voltage lightning arrester per phase. Special arrester requirements are shown on the drawings.

D. All CT circuits shall be supplied with shorting terminal blocks.

E. All circuit breakers shall be provided with external test ports/switches for monitoring PT, CT, and control power circuits.

2.6 CIRCUIT BREAKERS

A. The circuit breakers shall be horizontal drawout type, capable of being withdrawn on rails. The breakers shall be operated by a motor-charged stored energy spring mechanism, charged normally by a universal electric motor and in an emergency by a manual handle. The primary disconnecting contacts shall be silver-plated copper.

B. Each circuit breaker shall contain three vacuum interrupters separately mounted in a self-contained, self-aligning pole unit which can be removed easily. The vacuum interrupter pole unit shall be mounted on glass polyester supports. A contact wear gap indicator for each vacuum interrupter, which requires no tools to indicate available contact life, shall be easily visible when the breaker is removed from its compartment. The current transfer from the vacuum interrupter moving stem to the breaker main conductor shall be a non-sliding design. The breaker front panel shall be removable when the breaker is withdrawn for ease of inspection and maintenance.

C. The secondary contacts shall be silver-plated and shall automatically engage in the breaker operating position, which can be manually engaged in the breaker test position.

D. Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from housing and to discharge stored energy mechanisms upon insertion or removal from the housing. The breaker shall be secured positively in the housing between and including the operating and test positions.

E. The breakers shall be electrically operated by the following control voltages: 125-volt DC Close and 125-volt DC Trip. See drawings for select switchgears operating at 120VAC.

2.7 OVERCURRENT PROTECTION, PRIMARY AND SECONDARY

A. The switchgear manufacturer shall furnish and install, in the metal-clad switchgear, the quantity, type and rating of protection relays as indicated on the drawings and described hereafter in this specification. Reference one-lines for exact switchgear breaker and relaying configurations.

B. The provided circuit breakers shall be as follows:

1. As indicated on drawings

C. Each circuit breaker shall contain three vacuum interrupters separately mounted in a self-contained, self-aligning pole unit which can be removed easily. The vacuum interrupter pole unit shall be mounted on glass polyester supports. A contact wear gap indicator for each vacuum interrupter, which requires no tools to indicate available contact life, shall be easily visible when the breaker is removed from its compartment. The current transfer from the vacuum interrupter moving stem to the breaker main conductor shall be a non-sliding design. The breaker front panel shall be removable when the breaker is withdrawn for ease of inspection and maintenance.

D. The secondary contacts shall be silver-plated, or tin-plated, and shall automatically engage in the breaker operating position, which can be manually engaged in the breaker test position.

E. Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from housing and to discharge stored energy mechanisms upon insertion or removal from the housing. The breaker shall be secured positively in the housing between and including the operating and test positions.

F. The breakers and protective relays shall be electrically operated by the following control voltages:

1. 125-volt DC charge/close/trip. (See drawings for select gear that operates on 125-volt AC.
2. Each breaker shall be complete with control switch and red and green indicating lights to indicate breaker contact position.

2.8 OVERCURRENT PROTECTION

A. The Switchgear Manufacturer shall furnish and install, in the switchgear, the quantity, type and rating of protection relays as indicated on the drawings and described hereafter in this specification.

B. Protective relaying shall be microprocessor, high reliability, as specified below.

C. All relays will be of heavy-duty construction with conformal coating of all electrical components.

D. All protective relaying will be provided with serial and Ethernet ports factory wired to a common point within the switchgear enclosure. For Ethernet, this will include a centralized switch compatible with the relay communication protocol, compatible with MODBUS TCP/IP.

2.9 OTHER RELAYS

A. Bus Differential Relays (87) - Microprocessor-based three-phase relay. Provide relay with all required firmware and wired as shown on the one-line drawing.

1. SEL 587Z – High Impedance Differential Relay with high-speed operation.
2. Each SEL 587Z is to be provided with a stand-alone 86B lockout relay which will be used to transfer-trip each other breaker 86 relay.

2.10 INFRARED WINDOW

A. Two (2) 2” infrared (IR) windows shall be installed on each medium-voltage section. IR windows shall be Hawkeye, Fluke, or approved substitute.

2.11 AUXILIARY DEVICES

A. Ring type current transformers shall be furnished as indicated on the contract drawings. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. Their accuracy rating shall be equal to or higher than ANSI standard requirements. The standard location for the current transformers on the bus side and line side of the breaker units shall be front accessible to permit adding or changing current transformers without removing high-voltage insulation connections. Shorting terminal blocks shall be furnished on the secondary of all the current transformers.

B. Voltage and control power transformers of the quantity and ratings indicated in the detail specification shall be supplied. Voltage transformers shall be mounted in drawout drawers contained in an enclosed auxiliary compartment. Rails shall be provided for each drawer to permit easy inspection, testing, and fuse replacement. Shutters shall isolate primary bus stabs when drawers are withdrawn.

2.12 SPECIAL FEATURES

A. Test Ports: Switchgear shall contain covered test ports/test switches to allow access to all CT circuits and potential circuits from outside the compartment. Test ports for CT circuits shall contain shorting switches. Provide test ports for each circuit breaker compartment and for each differential circuit.

B. Shorting Terminals: Each current transformer shall be installed with screw shorting terminals for maintenance of the CT circuit.

C. Remote Operation: All breakers should be capable of remote operation from HMI. HMI shall display all information available from ATO system. HMI shall provide an adjustable breaker operational delay for allowing operator to walk clear from switchgear before breaker operation occurs.

D. Switchgear to be provided with condensation strip heaters in each cubicle.

2.13 CUSTOMER METERING

A. Provide customer metering devices where shown on the drawings. Where indicated, provide a separate customer metering compartment with front hinged doors. Include associated instrument transformers.

B. Metering is required to be SEL 735 for each Main and Feeder breaker.

C. Current transformers where shown on the drawings or elsewhere specified shall be wired to shorting type terminal blocks.

D. Potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings.

2.14 ENCLOSURES

A. The switchgear described in these specifications shall be indoor construction, with devices arranged as shown on contract drawings.

2.15 NAMEPLATES

A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16 inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish Master nameplate giving switchgear designation, voltage ampere rating, short circuit rating, manufacturers' name, general order number and item number.

B. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

2.16 FINISH

A. The finish shall consist of a coat of Gray (ANSI-61), thermosetting, polyester powder paint applied electrostatically to pre-cleaned and phosphatized steel and aluminum for internal and external parts. The coating shall have corrosion resistance of 600 hours to 5% salt spray. Prior to shipment, the complete assemblies, indoor as well as outdoor, shall be given 1.5 to 2.0 mil thick exterior finish spray coat of air drying high-gloss grey enamel.

2.17 ACCESSORIES

A. The switchgear manufacturer shall furnish accessories for test, inspection, maintenance, and operation, including:

1. (1) - Maintenance tool for manually charging the breaker closing spring and manually opening the shutter.
2. (1) - Levering crank for moving the breaker between test and connected positions.
3. (1) - Test jumper for electrically operating the breaker while out of its compartment.
4. (1) - Breaker lifting yoke used for attachment to breaker for lifting breaker on or off compartment rails.
5. (1) - Set of rail extensions and rail clamps.
6. (1) - Portable lifting device for lifting the breaker on or off the rails.
7. (1) - Electrical levering device.
8. (1) - Lump Sum all tape and insulating boots for insulating cable terminations.
9. (1) - Remote operation control unit capable of opening and closing and racking.
10. (1) – Test stand for breaker operation outside of cubicle.

2.18 BILLS OF MATERIAL

A. The metal-clad switchgear auxiliary section for control and instrumentation shall include the following:

1. Voltage transformers as shown on the drawings.
2. Additional control equipment as required.

B. Each metal-clad switchgear section for control of a main, tie, or feeder circuit breaker shall include the following:

1. One drawout power circuit breaker rated as shown on drawings.
2. One circuit breaker control switch with red and green LED Type indicating lights.
3. One nameplate.
4. One set of cable lugs.
5. All equipment specified in Equipment Schedule.

C. Automatic Transfer program for MVMSG-S12 and MVMSG-S34 shall be provided integral utilizing an SEL 3555 RTAC. Contractor/Vendor is responsible to fully program and configured RTAC to meet all the requirements as necessary for this control.

2.19 AUTOMATIC TRANSFER

A. See drawings for required sequence of operation

2.20 FACTORY TESTING

A. The following standard factory tests shall be performed on the circuit breaker element provided under this section. All tests shall be in accordance with the latest version of ANSI standards.

1. Alignment test with master cell to verify all interfaces and interchangeability.
2. Circuit breakers operated over the range of minimum to maximum control voltage.
3. Factory setting of contact gap.
4. One-minute dielectric test per ANSI standards.
5. Final inspections and quality checks.

B. The following production test shall be performed on each breaker housing.

1. Alignment test with master breaker to verify interfaces.
2. One-minute dielectric test per ANSI standards on primary and secondary circuits.
3. Operation of wiring, relays, and other devices verified by an operational sequence test.
4. Final inspection and quality check.

C. Factory tests as outlined above shall be witnessed by the owner's representative.

1. The manufacturer shall notify the owner two (2) weeks prior to the date the tests are to be performed.
2. The manufacturer shall include the cost of transportation and lodging for up to three (3) owner's representatives. The cost of meals and incidental expenses shall be the owner's responsibility.

D. The manufacturer shall provide three (3) certified copies of factory test reports.

PART 3 - EXECUTION

3.1 OPERATION AND MAINTENANCE MANUALS

A. Provide copies of the equipment operation and maintenance manuals as specified in the front-end specifications prior to final payment.

B. Operation and maintenance manuals shall include the following information:

1. Instruction books and/or leaflets.
2. Recommended renewal parts list.
3. Drawings and information required by Section 1.4.

3.2 HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. A draft copy of these instructions shall be supplied four (4) weeks prior to shipping. Two (2) final copies of these instructions shall be included with the equipment at time of shipment.

B. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.

C. Switchgear shall be equipped to be handled by crane. Where cranes are not available, switchgear shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

D. Switchgear being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition. If stored outdoors, indoor gear shall be covered and heated, and outdoor gear shall be heated.

3.3 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer's representative to assist the contractor in installation and start-up of the equipment specified under this section for a period of ten working days. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

3.4 FIELD ADJUSTMENTS

A. The relays shall be set in the field by the Contractor in accordance with settings designated by the Designer.

3.5 FIELD TESTING

A. The following tests shall be performed in the field:

1. Limited megger or high potential testing per manufacturer's recommendations.
2. Function test on each system and device.

3.6 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations.

B. The Vendor shall provide three (3) copies of the manufacturer's representative's certification before final payment is made.

3.7 TRAINING

A. The Contractor shall provide a training session for up to six (6) owner's representatives for one normal workday at a jobsite location determined by the owner.

B. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, circuit breaker, protective devices, and other major components.

3.8 CLEANING

A. Vendor shall supply touch-up paint.

B. Clean and dust all compartments.

C. Remove all paper from the enclosure.

3.9 PROGRAMMING

A. Commissioning vendor shall provide programming for all relay and RTAC devices per settings and coordination study provided by Engineer. Vendor shall be responsible to generate and supply to Engineer for review all programming files (.RDB) including setpoints and logic. Programming diagrams shall be provided in detail for review by the Engineer. Vendor is responsible to preload and complete relay programming files and incorporate those files into factory testing. Programming assistance shall be provided in the field to make any coordination adjustments necessary.

END OF SECTION 33 77 30