

SECTION 260100 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. The Drawings are schematic and are not intended to show the exact location of outlets, devices, etc. or the routing of conduit.
- B. Dimensions and information regarding accurate locations of equipment, and structural limitations and finish shall be coordinated and verified with other Divisions of Work. Be prepared to provide dimensions and information regarding the Work of this Division to other trades.
- C. The right is reserved to relocate any device (receptacle, switch, fire alarm, audio/visual, junction box, outlet, etc.) a maximum of 10'-0" before it is permanently provided without incurring additional cost to the Contract.

1.02 REFERENCE STANDARDS

- A. All work shall comply with the most recently revised versions of all local, state and federal codes, ordinances of the authority having jurisdiction, laws, rules and regulations. Any modifications required by any of the above shall be made without any additional cost to the owner. Where requirements between governing Codes and Regulations vary, the more restrictive provision shall apply.
- B. Nothing contained in the Contract Documents shall be construed as authority or permission to disregard legal requirements and regulations. The Contractor shall thoroughly review the Documents and bring any such conflicts to the attention of the Architect and Engineer prior to installation.
- C. All materials shall be new and shall bear the label of U.L.

1.03 EXISTING CONDITIONS

- A. Where work is to be performed in an existing facility, the contractor shall visit the site prior to bid and be familiar with all existing conditions. Special attention shall be given to work to be performed above an existing ceiling.
- B. Where existing slabs are to be cut or core drilled, the contractor shall x-ray the existing slabs to avoid cutting or disrupting existing conduits, cables, plumbing or structural members.
- C. The electrical service to the building shall not be interrupted without written consent of the building owner.
- D. No allowance will be made for lack of knowledge of existing conditions.
- E. At the completion of the project, all work under this Division shall be completely integrated with the existing systems and left in perfect operating condition.

- F. Where work under this Division disrupts the continuity of any existing to remain circuit or feeder, the Contractor shall repair/replace as necessary to return to a perfectly functional and safe operating condition.
- G. Prior to any demolition or construction, the Contractor shall have the existing conditions inspected by an EPA, OSHA certified asbestos abatement agency to identify the presence of asbestos. Should any asbestos be found it shall be brought to the immediate attention of the Architect and Owner and specifically identified in writing.

1.04 DEFINITIONS

- A. Provide: to furnish, install and connect.
- B. Furnish: to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for the proper and complete application.
- C. Install: to join, unite, fasten, link, attach, set-up or connect together, complete, tested, and ready for normal satisfactory operation.
- D. Engineer: The Engineer of record.
- E. Contract Documents: the complete set of Specifications and Drawings of all Divisions.
- F. Work: labor, materials, equipment, accessories, controls and other items required for a complete installation.
- G. Concealed: embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.
- H. Conduit: rigid steel; intermediate metal conduit (IMC), plastic conduit (PVC), electrical metallic tubing (EMT), or flexible steel conduit.
- I. Manufactured Cable: pre-wired metal clad manufactured cable bearing a U.L. label; metal clad cable (MC), health care (HCF).
- J. Wiring/Wired: all wire installed in conduit to equipment, device, junction box, light fixture, etc. from panel board or switchgear with all required boxes, connectors, couplings, etc.
- K. Exposed: not installed underground or concealed.
- L. Equal: equal in quality, workmanship, materials, weight, size, design and efficiency of the specified product, conforming to manufacturers.
- M. Supply: to purchase, procure, acquire and deliver complete with related accessories.

- N. Authority Having Jurisdiction (AHJ): applicable local, state and federal authorities having jurisdiction over any part of the Scope within this Division and other Divisions.

1.05 SHOP DRAWINGS AND PRODUCT DATA

- A. The Contractor shall obtain complete shop drawings, product data and samples from the manufacturers, suppliers, vendors for all materials and equipment as specified herein in various Sections of the Specifications, and shall submit data and details of such materials and equipment for review per Section 01 33 00.
- B. Shop drawings and/or product data shall be submitted for the following for review:
 - 1. Switchboards, panelboards, transformers, busway, motor control centers, ground fault system and other equipment associated with the main distribution.
 - 2. Disconnect switches, fuses, motor starters.
 - 3. Lighting fixtures, lighting control system, dimming system, emergency batteries and other equipment associated with lighting.
 - 4. Transient voltage surge protection.
 - 5. Generator, UPS, transfer switches, batteries, static switches, transition switches, switchgear and other equipment associated with emergency and/or standby back-up power systems.
 - 6. Devices, receptacles, switches, coverplates, motion sensors. The product data shall include the manufacturers name, model number, size and color.
 - 7. Conduit, wire, boxes, fittings.
- C. Shop drawing shall be submitted as one complete package for all electrical systems. Shop drawing will not be reviewed until all systems are provided to engineer.
- D. If the shop drawings are rejected, the engineer will review the submittal one additional time. If the shop drawings are rejected the second time, the engineers' time will be billed to contractor on hourly basis.

1.06 AS-BUILT DRAWINGS

- A. The Contractor shall maintain on a daily basis at the Project site a complete set of "Record Drawings". Project Record Documents shall be maintained as specified in Division 01.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturer's names and catalog numbers specified in the Contract Documents are intended to describe the material and set the standard of quality. All bids shall be based on material specified. Request for approval of material not specified shall be considered if the request is in written form and submitted to the Architect no later than fourteen (14) days prior to the bid date. All requests shall conform to the provisions of the general and supplementary conditions.

- B. When specific names are not stated, only the best available quality of material or equipment shall be submitted for review and used in the installation.

2.02 BASIS OF DESIGN

- A. Where a product is designated as "BASIS OF DESIGN", the Contractor is notified that mechanical, electrical, structural, architectural, space conditions and/or other features of the overall project design have been based on the requirements of the "BASIS OF DESIGN" product.
- B. Where a product is substituted for a "BASIS OF DESIGN" product, the Contractor shall notify the design team that changes in project design may be mandatory in order to permit use and installation of the substitute product. Shop drawing submittal for a substitute product shall include a complete schedule of changes in project design, if any, which must be made in order to permit use and installation of the substitute product. The Contractor shall be responsible for the coordination of all trades for use of the substituted product. The Contractor shall bear all expenses related to the use of a substitute product.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The equipment selections used in the preparation of the Contract Documents will fit into the physical spaces provided and indicated, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearance in accordance with the Code requirements and the requirements of the local Authorities having jurisdiction, and the equipment manufacturer 's recommendations.
- B. In the preparation of Drawings, a reasonable effort to accommodate acceptable equipment manufacturer's space requirements has been made. However, since space requirements and equipment arrangement vary according to each manufacturer, the responsibility for initial access, maintenance access, code required access, and proper fit rests with the Contractor.
- C. Physical dimensions and arrangements of equipment to be installed shall be subject to the Architect's and Engineer's review.
- D. The General Contractor and all Subcontractors shall coordinate the installation of ductwork, conduit, busway, piping, cable trays, etc., installation with lighting fixtures, special ceiling construction, air distribution equipment, and the structure. Provide additional rises, drops and offsets as required. If after installed, new ductwork, conduit, busway, piping or cable is found to be in conflict with the architecture, structure, or other trade Work which is either existing or shown on the Contract Documents, the ductwork, conduit, busway, piping or cable shall be relocated without additional cost to the Owner.
- E. No conduit, equipment, busway, etc., shall be installed in the eight (8) inch high zone directly above the ceiling in tenant areas to allow for tenant build-out and

flexibility unless otherwise specifically shown on the Drawings or prior written authorization is received from the Engineer.

- F. Accessibility and Clearance:
 - 1. Electrical equipment, outlets, junction and pull boxes shall be installed in accessible locations, avoiding obstructions, preserving headroom, and keeping openings and passageways clear.
 - 2. Minor adjustments in the locations of equipment shall be made where necessary, providing such adjustments do not adversely affect functionality of the equipment.
- G. Scaffolds and staging for installation of electrical work shall be provided under the work of this Division.

3.02 STRUCTURAL FITTINGS

- A. Provide the necessary sleeves, inserts, hangers, anchor bolts, and related structural items. Provide at the proper time.
- B. Openings may have been indicated on the Architectural and Structural drawings. Should any additional openings or holes be required, the same shall be provided at no additional cost to the Owner.
- C. Location: At a time in advance of the work, verify openings shown on the Architectural and Structural drawings, and coordinate any additional openings.
- D. If the work of this Section requires modification of the Architectural or Structural drawings, provide new instructions as to requirements for these openings. Submit for review and coordination to Architect.
- E. Sleeves shall be supplied for electrical conduits passing through walls or slabs and shall be placed before concrete is poured.
- F. Equipment supports for electrical work shall be fastened to the structure by inserts, anchor bolts, bolting to drilled and tapped structural members, or be welded to the structure.
 - 1. Welding shall be done by the electric arc method with fully competent welders. Supporting members shall be shop coated with a suitable primer.
 - 2. Surfaces damaged by installation of supports shall be touched up with primer to match shop coat. Any drilling of structural members shall be approved by the Architect.
- G. Flashing:
 - 1. Wherever conduits pass through the roof or outer walls, base flashing and counter flashing shall be provided.
 - 2. Such flashing shall be properly installed by skilled workmen, and shall include grouting, mastic or tar application, or other means to insure a permanent, waterproof, neat and workmanlike installation.

3. Insofar as possible, flashing shall comply with and be similar to requirements for flashing in General Construction Work.
- H. Anchor bolts and inserts shall be galvanized and of adequate size and strength for installation of electrical work and shall be placed in forms before concrete is poured.
 1. Placement of bolts in bases shall be done under other Division. Provide detail drawings, templates, and anchor bolts for bases to the General Contractor in time to avoid delaying work schedules.
 2. Expansion shields shall only be used with specific approval of the Architect. Wooden or soft metal plugs shall not be used.
- I. Cutting and patching:
 1. All additional cutting, patching and reinforcement of construction of building, subject to review by the Architect, shall be performed under this Section.
 2. Refer to appropriate Division for requirements.

3.03 WEATHERPROOF EQUIPMENT

- A. Electrical devices or equipment located in damp; semi-exposed areas shall be weather-resistant. Enclosures shall comply with NEMA Type 3R requirements.
- B. Surface mounted outlet boxes shall be cast metal with threaded bolts. Pull or junction boxes shall be cast metal with bolted and gasketed covers.
- C. Outlet box covers shall be of a suitable weatherproof type with gaskets, packing glands, weatherproof doors, or other required means to prevent entry of moisture.
- D. Lighting fixtures shall be provided with suitable gasket, and UL labeled for location.

3.04 CLEANING

- A. Brush and clean work prior to concealing, painting and acceptance. Perform in stages if directed.
- B. Painted exposed work soiled or damaged: Clean and repair to match adjoining work before final acceptance.
- C. Remove dust and debris from inside and outside of material and equipment.

3.05 IDENTIFICATION OF CIRCUITS AND EQUIPMENT

- A. Numbered adhesive strip tags shall be attached to branch circuit wiring in conduits at every point where runs are broken or terminated. Also tag pull wires in empty conduits.
- B. Junction and Pull boxes shall have covers stenciled with box number when shown on the drawings, or circuit numbers according to panel schedules. Data shall be lettered in a conspicuous manner with a color contrasting to finish.

- C. All feeders for switchboard shall have labels that indicate the phase and designation.

3.06 TESTS AND DEMONSTRATIONS

- A. All systems shall be tested in the presence of the Owner or an Owner designated representative upon completion of the Work and demonstrates that the installation is in accordance with the Contract Documents.
- B. All motors shall be checked and adjusted for correct direction of rotation.
- C. Loading of circuits and feeders in panelboards shall be checked and balanced.
- D. Any work found not to be in compliance with the Contract documents shall be repaired or replaced without incurring additional cost to the Contract price.
- E. Provide all instruction to the Owner on maintenance and operation of all systems and equipment provided under this Division.

3.07 WARRANTIES

- A. The warranty period for all systems, equipment, components, work, etc. shall be no less than one (1) year, unless specified otherwise hereinafter and shall include at least one (1) full heating season and one (1) full cooling season.
- B. The Contractor shall, without cost to the Owner, remedy any defects within a reasonable time to be specified in notice from the Architect. In default thereof, the Owner may have such work done and charge all costs to the Contractor.
- C. The start of the Contractor's warranty period, as defined in the General Conditions, shall commence on the issue of a "Certificate of Substantial Completion", by the Owner or the Owner's Representative for each item of material, equipment or system.
- D. The Subcontractor shall confer with the General Contractor prior to the bid date concerning the project schedule and determine if there is a need to operate any items of equipment or systems for temporary heating an/or cooling or other reasons prior to "Substantial Completion". All required extended warranty costs for equipment, materials, and systems shall be included in the Subcontractor's bid.

END OF SECTION 260100

SECTION 260500 - RACEWAYS AND WIRING – 600 VOLT

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide all raceways and wiring specified herein and as required to provide a complete system throughout the project as indicated on the Drawings.

PART 2 - PRODUCTS

2.01 CONDUIT

- A. Galvanized Rigid Steel Conduit (GRC): Rigid steel conduit shall be galvanized, constructed of high-grade raw steel piping, galvanized inside and outside with threaded joints.
- B. Intermediate Metal Conduit (IMC): IMC shall be constructed of high-grade steel tubing, galvanized inside and outside with threaded joints. Zinc coating shall be applied by the hot-dip, galvanized process.
- C. Electrical Metallic Tubing (EMT): EMT shall be constructed of high-grade steel, zinc coated and galvanized inside and outside.
- D. Rigid Plastic Conduit (PVC): PVC conduit shall be polyvinyl chloride rigid scheduled to heavy wall type. PVC conduit shall be joined with PVC couplings of the solvent cement type to provide complete watertight joints. Conduit systems shall be UL listed for direct burial and exposed use.
- E. Flexible Metal Conduit: Shall be flexible steel conduit tubing spirally wound having a hot-dip galvanized coating and meeting requirements of UL for flexible metal conduit.
- F. Liquid tight Flexible Metal Conduit: Shall be flexible steel conduit spirally wound and shall have a copper grounding strand and factory-applied neoprene jacket. Liquid tight flexible conduit shall meet the requirements of UL.

2.02 CONDUIT FITTINGS

- A. GRC and IMC: shall be factory-made taper threaded and of the same material as the conduit. Provide with molded nylon insulating bushing or throat at all boxes and cabinets with locknuts inside and outside. Provide watertight hubs in wet locations for terminations into enclosures. Provide insulated grounding bushing where required.
- B. EMT: shall be of the same material as the conduit and shall be hexnut compression or steel setscrew. Provide with molded nylon insulating bushing or throat at all boxes and cabinets. Provided insulated grounding bushing where required.
- C. PVC: shall be Schedule 40 and of the same manufacturer as the conduit.

- D. Flexible Metal Conduit and Liquidtight Flexible Metal Conduit: Provide couplings at connections between flexible and rigid conduit suitable for that application. Provide with nylon-insulated busing or throat at all boxes and cabinets with locknuts.
- E. Expansion Joints: Provide O.Z./Gedney, Type AX expansion joint fittings for all conduit which crosses an expansion joint. Provide with internal ground and external bonding jumper.
- F. Wire Support Bushings: Provide for vertical runs as required by the NEC.

2.03 PRE-WIRED MANUFACTURED CABLE

- A. Pre-wired manufactured cable may be used for branch circuit wiring for receptacle and lighting circuits where acceptable by the AHJ.
- B. Pre-wired manufactured cables shall NOT be used for:
 - 1. Mechanical equipment branch circuits
 - 2. Feeders
 - 3. Homeruns
 - 4. Exposed
- C. Conduits connecting receptacle and switch circuits to lighting and power homerun boxes in finished areas, type "MC" cable consisting of one (1), two (2), three (3) or four (4) copper "THW", "THHN" or "THHN/THWN" insulated phase, neutral and ground conductors. Ground shall be of minimum size required by NEC, as specified in other Sections and as noted on the Drawings.
- D. Pre-wired cables used for receptacle and equipment through-out a "health-care facility" shall be type "HCF", with a continuous green colored metal sheath UL approved for grounding purposes. HCF cable shall NOT be used for Essential Electrical System (Life Safety, Critical, Equipment) branch circuits.
- E. Pre-wired manufactured cable may be used where concealed in walls or in millwork only. Cable shall run from the first device in the wall or millwork or first light fixture to a structurally mounted junction box no more than 10'-0" from the point which the cable enters the ceiling space or from first light fixture.
- F. Cable shall not pass through a fire rated wall or assembly.
- G. Acceptable cable manufactures are AFC, Alflex and Southwire.
- H. Cable termination fittings shall be O. Z. Gedney C5, T&B #253, Steel City Series XC-400 or approved equal clamp-type, malleable iron fittings. Die-cast fittings are not acceptable.

2.04 JUNCTION BOXES AND PULL BOXES

- A. Junction boxes and Pull boxes shall be galvanized steel with mode size and gauge as required by the NEC in accordance with voltage parameters. Covers shall be of the same gauge as the box as shall be screw fastened. Boxes shall be sized as required but no smaller than 4 inches square and 1-1/2 inches deep.

- B. Covers shall be accessible.
- C. Provide galvanized cast iron or aluminum with threaded hubs and gaskets for outdoor and damp locations.
- D. Boxes in grade or underwater shall be cast brass or bronze.

2.05 OUTLET BOXES

- A. Outlet boxes shall be UL listed, and of sizes and types required for the application.
- B. Boxes Recessed in Construction: Sheet steel boxes, unless noted or required otherwise. Boxes shall be no lighter than 14 gauge and shall be galvanized after fabrication. Set so face of box will finish flush with building surface.
 - 1. For Lighting Fixture Outlets: 4-inch square with raised fixture ring.
 - 2. For Wall Switches, Receptacles, and Communication Use: 4-inch square, one-piece; no sectional boxes permitted. Use boxes with plaster rings in all plastered walls where wall thickness permits. Use boxes less than 1-1/2-inch-deep only in locations where deep boxes cannot be accommodated by construction.
- C. Boxes Used Outdoors or in Damp/Wet Locations: Cast metal boxes (iron and alloy) with gasketed covers and threaded hubs.
- D. Boxes in Hazardous Areas: Approved cast metal boxes with appropriate sealing fittings.
- E. Provide blank cover for boxes without fixture or device.
- F. Boxes in grade or underwater shall be cast brass or bronze.
- G. Cyclocac: Per code for pools and fountains only.

2.06 WIREWAYS AND AUXILLARY GUTTERS

- A. Wireways shall be constructed in accordance with UL 870. Every component including lengths, connectors, and fittings shall be UL listed and labeled. Provision shall be included in the construction to allow screwing the hinged cover closed without the use of parts other than the standard lengths, fittings, and connectors. It shall also be possible to seal the cover in the closed position with a sealing wire.
- B. Wireways shall be constructed with/without knockouts, as required. Enclosure type shall be as required by conditions encountered.
- C. Gutters and Wireways shall be suitable for "lay-in" conductors. Connector covers shall be permanently attached so that removal is not necessary to utilize the lay-in feature.
- D. All sheet metal parts shall be provided with a rust-inhibiting phosphatizing coating and gray baked enamel finish. All hardware shall be plated to prevent corrosion. All screws installed toward the inside shall be protected by spring nuts or otherwise guarded to prevent wire insulation damage.

- E. All connectors shall be slip-in type with self-retaining mounting screws. All hangers shall be two-piece with hook-together feature to permit pre-assembly of wireway and hanger bottom plate before hanging on pre-installed upper bracket.

2.07 SURFACE METAL RACEWAY

- A. Surface metal raceway shall be UL listed and labeled; shall be used together with couplings, clips, bushings, straps, connectors, connection covers, elbows, extension boxes, fixture boxes, extension adapters, blank covers and all other required fittings; shall be of the proper size to accommodate the conductors to be installed therein in each case.

2.08 CONDUCTORS – 600 VOLTS OR LESS

- A. Provide conductors of stranded copper, 98% conductivity, new building wire, insulated in accordance with the requirements of the NEC. Insulation shall be rated no less than 600-volt. Conductors shall be Type “THWN” or “THHN/THWN”. Conductors for service and distribution feeders shall be “XHHW”. Solid conductors terminating in a breaker or device shall be utilized for wire size No. 12. Sizes specified are AWG gauge for No. 4/0 and smaller and circular mils (kcmil) for sizes larger than No. 4/0. Minimum wire size shall be No. 12.
- B. Connectors: Make splices and connections in conductors using UL connectors.
 - 1. Stranded Conductors: UL listed, solderless, bolted pressure or compression connectors. Connectors shall be of proper sizes to match conductor sizes.
 - 2. Solid Conductors: UL listed, bolted pressure or spring connectors. Connectors shall be of proper sizes to match conductor sizes.
 - 3. Motor Lead Pigtails: UL listed, crimp lugs with through-bolt fasteners between lugs. Lugs shall be of proper sizes to match conductors. Proper sized dies and tools shall be provided to apply connectors.
 - 4. Lighting Fixture Taps: Electrical spring connectors as specified for solid conductors.
 - 5. Ground connections: Burndy ground clamps or connectors of a type suitable for and having a UL listing for grounding applications.
- C. All conductor sizes shown on the Drawings are copper unless specifically noted otherwise. All ground conductors shall be copper.
- D. ?? [Aluminum] Aluminum conductors may be used for the following if the same or larger capacity of those copper conductors shown or specified and conduits sizes adjusted accordingly. Aluminum conductors shall be hi-compression type. All terminations shall utilize compression fittings. Conductors shall be torqued based on manufacturer's recommendation:
 - 1. Service laterals
 - 2. Panel/Switchboard distribution feeders 400 AMPS and larger terminating in switch gear, distribution panels, panelboards and transformers.
 - 3. All grounds shall be copper.

2.09 MANUFACTURERS

- A. Conduit (GRC, IMC, EMT)

1. Allied
 2. Republic
 3. Triangle
 4. Wheatland
- B. Conduit Fittings (GRC, IMC, EMT)
1. Appleton
 2. O.Z. Gedney
 3. Steel City
 4. Thomas and Betts
 5. Raco
- C. Flexible Metal Conduit
1. AFC
 2. Alflex
 3. Anaconda
 4. International Metal Hose
- D. Liquidtight Flexible Metal Conduit
1. American Brass Company
 2. Anaconda
 3. Electri-Flex Company
- E. PVC Conduit and Fittings
1. Thomas & Betts
 2. Prime Conduit
 3. Cantex
 4. Certainteed
 5. Triangle
- F. Conductors, Copper, 600 Volts or less
1. American Insulated Wire
 2. Cablec
 3. General Cable
 4. Pirelli
 5. Southwire
 6. Triangle
- G. Conductors, Aluminum, 600 volt or less (where specified)
1. Alcan Cable
 2. Cablec
 3. Southwire
- H. Outlets and Boxes
1. Appleton
 2. Raco
 3. Steel City
 4. Midland

PART 3 - EXECUTION

3.01 CONDUIT

- A. PVC (encased in 4" concrete on all sides) or Galvanized Rigid Steel (GRC) meeting corrosion resistant protection of NEC 300.6 shall be used for underground service entrance and underground feeders. When PVC is used, a transition to metal conduit shall be made below grade using GRC 90 degree fitting such that only metal conduit exits concrete or ground.
- B. GRC or Intermediate Metal Conduit (IMC) shall be used where exposed and subject to physical damage or installed in damp or wet locations.
- C. PVC shall be used for underground branch circuits, underground feeders where run below the slab on grade, 1" maximum in the slab on grade, 1" maximum in the slabs above grade, in concrete columns and concrete wall and in masonry walls.
- D. PVC Schedule 80 (or GRC meeting corrosion resistant protection of NEC 300.6) may be used for direct burial for branch circuits only. When PVC is used, a transition to metal conduit shall be made below grade using GRC 90 degree fitting such that only metal conduit exits concrete or ground
- E. Electrical Metallic Tubing (EMT) shall be used for branch circuits concealed in walls and ceilings. EMT may be used for feeders where not exposed to damage and/or not installed in wet or damp locations.
- F. Flexible Metal Conduit shall be used for connections to rotating or vibrating equipment. The lengths shall be as short as possible, in no case longer than 6' or shorter than 12".
- G. Liquidtight Flexible Metal Conduit shall be used for connections to rotating or vibrating equipment where located outdoors or in damp or wet locations. The lengths shall be as short as possible but in no case longer than 6' or shorter than 12". Liquidtight Flexible Metal Conduit shall NOT be located above a ceiling, in an air shaft or in a mechanical room utilized as a return air plenum.
- H. Raceways shall be installed as a complete and total wiring enclosure system from outlet to outlet, to junction box, pull box, panel or cabinet prior to the installation of the conductors.
- I. All conduit shall be run concealed (except in electrical, mechanical and similar area) unless shown otherwise. Where conduit is run exposed it shall be run in a neat and orderly manner. All conduit shall be run parallel and perpendicular to the building structure.
- J. Conduits shall be secured to all boxes, cabinets, panels and equipment with locknuts and bushings and shall be securely fastened in place on intervals required by the Code and local codes; hangers, supports or fastenings shall be provided at each elbow and at the end of each straight run within 3' of a termination to a box or cabinet. All supports shall be independent and shall not use ceiling supporting system wires.

- K. Use threaded rods and hangers for supporting single conduit. Multiple conduits shall be supported using a trapeze of Unistrut (or Kindorf) channels and threaded rods with double nut/washer.
- L. Provide pullboxes as shown and/or as required by Code and where necessary in the raceway system to avoid excessive runs or too many bends. Boxes shall have removable hinged or screw covers and shall be accessible.
- M. The minimum size conduit shall be ½" diameter. Homeruns shall extend from the first outlet or device to the panel designated and shall be a minimum ¾" diameter.
- N. Provide non-hardening elastic type duct seal compound for each conduit entering the building from the outside and from one space to another having a normal operating temperature differential greater or less than 10 degrees F.
- O. Provide seals around all conduit and sleeves penetrating through walls, partition or ceilings. Provide UL approved fire-resistant seal around all penetrations through fire rated barriers to maintain the barrier rating.
- P. Provide pull wire or nylon rope in all empty conduits.

3.02 CONDUIT PROTECTION

- A. Provide underground conduit with a top cover at least 30" below finished grade and no more than 48".
- B. Mark all duct bank runs with a detectible warning tape specifically formulated for prolonged use underground, resistant to alkalis and acids found in soil, installed no less than 8 inches and no more than 12 inches above the top of the duct bank concrete. Place warning tape along the approximate center line of the duct bank run. Warning tape shall be permanent, red in color, continuous printed, aluminum backed tape, compounded for direct burial not less than 3 inches wide and 4 mils thick. Printed legend shall be indicative of general type of underground line below.
- C. Mark all underground conduit runs with a detectible warning tape specifically formulated for prolonged use underground, resistant to alkalis and acids found in soil, installed no less than 6 inches and no more than 10 inches above the top of the conduit. Place warning tape along the approximate center line of the conduit run. Warning tape shall be permanent, red in color, continuous printed, aluminum backed tape, compounded for direct burial not less than 3 inches wide and 4 mils thick. Printed legend shall be indicative of general type of underground line below.
- D. Future

3.03 CONDUCTORS – 600 VOLTS OR LESS

- A. No conductor shall be smaller than No. 12 except for signal or control circuits.
- B. All conductors shall be installed in conduit.

- C. Where a connection is made to any terminal of 40 amperes or more and/or conductors No. 8 or larger, copper terminal lugs shall be bolted to the conductors. Where multiple terminal lugs are made, individual lugs for each conductor shall be used. Where aluminum conductors are accepted in this Section or noted on the drawings, the terminations shall be made with high compression lugs as manufactured by Ideal or MAC.
- D. A maximum of six (6) current carrying conductors shall be run in a conduit. The neutral shall be considered a current carrying conductor.
- E. For homeruns of 120 Volt, 20-amp circuits, where the length of run from the panelboard to the center of the load exceeds 100'-0" the conductors shall be No. 10 minimum. If that length exceeds 200'-0" the conductors shall be No. 8 minimum.
- F. For homeruns of 277 Volt, 20-amp circuits where the length of run from the panelboard to the center of the load exceeds 200'-0" the conductors shall be No. 10 minimum.
- G. Multiple branch circuits homeruns serving computer loads, electronic lighting ballasts and/or H.I.D. lighting ballasts shall utilize a neutral conductor one trade size larger than the phase conductors or use separate neutrals for each circuit. Neutral conductors for individual branch circuits may be the same size as the phase conductor but not less.
- H. Provide an equipment grounding conductor in all feeder and branch circuit conduits. Size per code unless shown otherwise.
- I. Conductors shall have color coded jackets the entire length for sizes No. 6 and smaller. The conductors for sizes No. 4 and larger shall have color coded jackets the entire length. Colors shall be as follows:

120/208 Volt System	277/480 Volt System
Phase A – Black	Phase A – Brown
Phase B – Red	Phase B – Orange
Phase C – Blue	Phase C – Yellow
Feeder or Shared Neutral – White	Feeder or Shared Neutral – Gray
Branch Phase A Neutral – White w/ Black Stripe	Branch Phase A Neutral – White w/ Brown Stripe
Branch Phase B Neutral – White w/ Red Stripe	Branch Phase B Neutral – White w/ Orange Stripe
Branch Phase C Neutral – White w/ Blue Stripe	Branch Phase C Neutral – White w/ Yellow Stripe
Ground - Green	Ground - Green

- J. Where phase marking tape is used it shall be wrapped 2" wide and located at two (2) locations 6" and 18" from the termination. Phase marking tape for the neutral and grounding conductors shall be provided where visible at any point where the conductor is accessible.

- K. Before pulling any wire into conduit, thoroughly swab the conduit and clean the boxes of debris.
- L. Run feeders in continuous lengths, without joints or splices. Joints shall occur in branch circuits only in locations where they divide.
- M. Run conductors for emergency power in conduits separate from all other wiring.
- N. Bundle conductors in switchboards and panelboard cabinets and similar using nylon straps made for the purpose. Conductors No. 8 and larger shall be bundled in individual circuits.

3.04 JUNCTION BOXES, PULL BOXES, AND OUTLET BOXES

- A. All junction boxes and pullboxes shall be sized in accordance with the Code.
- B. All boxes shall be rigidly secured in position to building structure. Boxes larger than 4" shall be secured at two points.
- C. Outlet boxes shall be flush with the finished wall or ceiling, or not more than ¼" back, unless specifically shown as surface mounted or its purpose is to be above the ceiling.
- D. Provide galvanized steel or cast type outlet boxes. Where exposed GRC or IMC terminates in a box, provide cast box with threaded hubs.
- E. All boxes shall be provided with a cover plate.
- F. All outlet boxes shall be mounted vertically unless noted otherwise.
- G. Where outlets are shown at the same location but at different heights, they shall be mounted one above the other along the same centerline.
- H. The exact mounting height of an outlet may be adjusted slightly to align with masonry joint where approved by the Architect.
- I. Verify outlet locations in finished spaces with Drawings of interior details and finishes.
- J. Outlets shall NOT be located back to back. Where outlets are shown on opposite sides of a wall, they shall be located in separate stud spaces.
- K. Protect floor boxes from entering debris during construction using temporary covers approved by the floor box manufacturer.
- L. Provide barriers in outlet boxes for switches separating different phases for voltages exceeding 150 volts to ground.
- M. Boxes shall not be supported from a suspended ceiling.

END OF SECTION 260500

SECTION 260526 - GROUNDING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide all equipment, materials, tools, and labor to provide a complete grounding system.
- B. Ground all metallic parts of the electrical system which are not intended to carry current such as conduit, busduct, switchgear, panelboards, cabinets and enclosures, motor frames, device boxes, etc., in accordance with the NEC and applicable codes.
- C. In non-metallic conduits, maintain continuity of equipment grounding by installing an insulated grounding conductor and connected by an acceptable method.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All equipment and materials provided under this Section of the Specifications shall be new, UL listed, and bear the UL label.
- B. All switchboards, panelboards, motor control centers, transformers, busway, etc. shall be provided with a copper equipment ground bar bolted, brazed, or riveted to the associated enclosure or cabinet. All receptacles, switches, disconnects, individual motor controllers, etc. shall be provided with a grounding terminal connected to the device frame or enclosure.
- C. All conduit, cable tray, manufactured wiring systems, raceways, junction boxes, pull boxes, etc. shall be made electrically continuous by means of grounding conductors, bonding jumpers, grounding bushings, etc. as required by the NEC and the authorities having jurisdiction.
- D. Refer to other Sections for additional grounding requirements.

2.02 GROUNDING CONDUCTORS

- A. All grounding electrode conductors shall be bare or green insulated copper conductors sized per the NEC, unless noted on the Drawings. Where the authorities having jurisdiction or local code requires grounding electrode conductor sizing in excess of that shown on the Drawings or specified herein, the larger size conductor shall be installed.
- B. All equipment grounding conductors shall be green insulated copper conductors sized as indicated on the Drawings. Where the authorities having jurisdiction or local code requires equipment grounding conductor sizing in excess of that shown on the Drawings or specified herein, the larger size conductor shall be installed.

- C. All bonding conductors shall be flexible copper bonding jumpers sized in accordance with the NEC for grounding electrode conductors.

2.03 GROUND RODS

- A. All ground rods shall be a minimum of 3/4" x 10'-0" copper clad steel unless otherwise indicated on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide adequate and permanent service neutral and equipment grounding in accordance with the NEC and as follows.
- B. Each system of electrically continuous metallic piping and ductwork shall be electrically grounded in accordance with the requirements of the NEC for "bonding" as they apply to the "bonding of piping systems". Isolated metallic piping and duct systems shall be bonded to the building equipment grounding system.
- C. Bonding and grounding conductors shall be sized, shall be run in conduit, and shall be connected to various services in accordance with the requirements of the authorities having jurisdiction and the NEC.
- D. Grounding Electrode System
 1. Provide a made electrode consisting of three (3) ground rods spaced 6' apart in the form of an equilateral triangle. Each rod shall be installed a minimum of 12" below finished grade and a minimum of 36" clear of the foundation with No. 3/0 bare stranded copper conductors bonded together 24" below finished grade to form a loop (grounding triad). Provide an accessible underground rod test well for each ground rod.
 2. Extend from the made electrode a No. 3/0 insulated stranded copper conductor in a 1 1/4" conduit to a single point ground bar (Erico EGBA144**GG Length as required) at each main service disconnect and connect to the main disconnect neutral bar, housing and frame using No. 3/0 stranded conductor.
 3. Provide a building grounding riser as follows:
 - a. Provide a single point ground bar in the main electrical room connected to the made electrode and each service main disconnect with a No. 3/0 insulated stranded copper conductor in a 1" conduit.
 - b. Provide a ground bar (Erico EGBA14412GG) in each branch electrical room connected to the ground bar in the main electrical room with a 250kcmil insulated stranded copper conductor in a 1 1/2" conduit.
 - c. Provide a ground bar (Erico TGBA 16L08PT) in each communications room (and other rooms as noted on the Drawings) connected back to the closest electrical room ground

- bar on the same floor with a #2 insulated stranded copper conductor in a 1" conduit.
5. The following electrodes shall be bonded together with a No. 3/0 insulated stranded copper conductor in 1" conduit to form a grounding electrode system:
 - a. Made electrode described above.
 - b. Underground main metallic water pipe. Connect ahead of the first valve and provide a bonding jumper across the water meter.
 - c. Structured steel building frame.
 - d. Where the above electrodes are not available or feasible, provide suitable grounding electrodes per NEC.
 6. Where nonmetallic insulating coupling, dielectric flanges or similar are used in metallic water piping, provide a No. 3/0 insulated stranded copper conductor across the couplings with the conductor attached to the water line with clamps on each side of the coupling.
 7. Provide exothermic type chemical welded type connectors (Cadweld or approved equal) for the joining of conductors to ground rods, grounding plates and splicing. Provide compression and bolted type connectors for the joining of grounding electrode conductors to the ground bars.
 8. Provide a separate green-insulated equipment grounding conductor, with insulation of the same rating as the phase conductors, for all feeders and branch circuits. Install the grounding conductors in the raceway with related phase and neutral conductors. Where parallel conductors in separate raceways occur, provide a grounding conductor in each raceway. Connect all grounding conductors to ground terminals at each end of the run so that there will be no uninterrupted grounding circuit from the point of ground fault back to a point of connection of the equipment ground and system neutral.
 9. Connect the secondary neutral point and the enclosure in each dry type transformer together and run a grounding electrode conductor from their common point of connection to the building grounding electrode system.
 10. Provide grounding bushings on all raceways terminating within all electrical enclosures. Provide grounding conductors from such bushings to the frame of the enclosure, ground bus and equipment grounding strap where one occurs.
 11. Connect the unit substation neutrals where applicable and equipment ground to a common point within the metallic enclosure containing the main service disconnecting means. Equipment grounds and the identified neutral of the wiring system shall not be interconnected beyond this point in the interior wiring system.
 12. Assure the electrical continuity of all metallic raceway systems, pulling up all conduits and/or locknuts wrench tight. Where expansion joints or telescoping joints occur, provide bonding jumpers. Wherever flexible metallic conduit is employed, provide a green insulated ground jumper installed in the flexible conduit.
 13. Provide an insulated green bonding jumper from the grounding screw in the outlet box. Do not install behind the device mounting screws.
 14. Provide a No. 6 copper ground to the telephone company main distribution frame and to each telephone backboard.

3.02 TESTS

- A. Provide ground continuity tests at all switchboards, transformers, panel boards, distribution panels, motor control centers, main disconnects and transfer switch equipment.
- B. After completion of the grounding system measure the system ground resistance. If the resistance to ground exceeds 5 ohms, additional ground rods, or other method approved by the Engineer, shall be provided until a reading of 5 ohms or less is achieved.
- C. Perform tests in dry weather and not less than 48 hours after rainfall.
- D. Test instruments: Null balance type, Biddle Meggar Earth Tester or approved equal.
- E. Provide a report with all resistance readings, calculations and performed corrections and submit two (2) copies to the Architect.

END OF SECTION 260526

SECTION 260550 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide all equipment, materials, tools and labor to properly identify electrical equipment and related accessories.
- B. Provide identification for the following:
 - 1. Switchgear, switchboards, distribution panels, panelboards, disconnect switches, circuit breakers, motor starters, motor control switches, start/stop buttons, EPO switches, and other electrical equipment.
 - 2. Junction boxes and pullboxes.
 - 3. Wiring devices.
 - 4. Wiretags for wiring.
 - 5. Raceways.
- C. Related Section
 - 1. 26 24 00 – Service and Distribution.
 - 2. 26 27 00 – Devices.
 - 3. 26 29 00 – Motor Controls and Wiring.

PART 2 - PRODUCTS

2.01 IDENTIFICATION

- A. Nameplates
 - 1. Nameplates shall have the surface color and core color for engraved letters as follows:
 - a. Normal distribution
 - 1) 277/480V. equipment – white surface with black core
 - 2) 120/208V. equipment – black surface with white core
 - b. Emergency distribution
 - 1) 277/480V. equipment – white surface with red core
 - 2) 120/208V. equipment – red surface with white core
 - 2. Provide a nameplate for each switchgear, switchboard, panelboard, distribution panel, motor starter, disconnect switches, motor control center and similar distribution equipment clearly identifying the equipments' name to match that indicated in the Drawings.
 - 3. Provide a nameplate for each feeder protective device in each switchgear, switchboard, distribution panel, motor control center and any other similar equipment. Identify the specific load it serves.
 - 4. Nameplates shall be bakelite, 1/16" thick minimum with 3/8" high letters.
- B. Junction Boxes and Pull boxes
 - 1. Provide identification with permanent ink marking pen on the cover of junction boxes noting the branch circuits and systems within the conduit.
 - 2. Pullboxes shall be marked using stenciled paint noting the voltage and systems served. Letters shall be appropriate height so that they can be read from the floor.

3. Boxes containing Emergency systems: write the abbreviation "EMER" above the circuit number on junction box covers. Write "EMERGENCY" in stenciled "RED" paint on pullboxes above other markings.
- C. Disconnect switches and motor starters
1. Provide nameplates as described above for all disconnect switches and motor starters located 8'-0" above finished floor or less. Identify equipment served.
 2. Provide identification with permanent ink marking pen on all disconnect switches and motor starters mounted over 8'-0" above finished floor. Write marking clearly and in a location that can be read from the floor when the area is finished (e.g. marking for disconnects serving mechanical equipment that will be above the ceiling when the area is finished shall be located on the bottom or bottom front of the disconnect so it can be read when a ceiling tile is removed).
- D. Wiring device wall plates
1. For critical care outlets in health care facilities provide identification on the face of the coverplate with red printed lettering on a white adhesive background as to the panel and circuit the outlet is served. Characters shall be 1/4" high.
- E. Push button switches
1. Provide nameplates as described above for all push button switches. Letters shall be 1/4" high.
- F. Emergency power off buttons (EPO)
1. Provide nameplates as described above for EPO switches. Nameplate shall have a red surface and a white core. The letter shall be 1/2" high reading "EMERGENCY POWER OFF".
- G. Wire markers
1. Wire markers for identification of wiring shall be self-adhesive type having letters and numerals indicating feeder or branch circuit number. Locate markings on wiring where visible near the terminations and taps in all junction boxes, outlet boxes, panelboards, distribution panel boards, switchboards and motor control centers.
- H. Electrical services
1. Where multiple electrical services are provided to a building, provide nameplates as described above identifying the appropriate service number. Letters shall be 1" high.
 2. Where the multiple electrical services are in different locations, provide a nameplate at each service noting the locations of the other service(s) as required by the NEC and the AHJ.

PART 3 - EXECUTION

- A. Nameplates shall be applied to a cleaned surface and shall be plumb and level.

END OF SECTION 260550

SECTION 262400 - SERVICE AND DISTRIBUTION – 600 VOLT

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide all distribution switchgear as specified herein, as indicated on the Drawings and as required to provide a complete and operating system. All distribution equipment shall be of the same manufacturer including, but not limited to, switchboards, panelboards, transformers, disconnects, and busway.
- B. The distribution equipment shall be designed, manufactured and tested in accordance with the latest version of the following standards:
 - 1. NFPA 70
 - 2. NEMA AB1
 - 3. NEMA KS1
 - 4. NEMA PB2
 - 5. NEMA PB1
 - 6. NEMA PB1.1
 - 7. NEMA PB2.1
 - 8. NEMA PB1.1
 - 9. NEMA 250
 - 10. NEMA TP-1-2002
 - 11. ANSI/IEEE C12.1
 - 12. ANSI C39.1
 - 13. ANSI C57.13
 - 14. UL 50, 67, 89, 98, 489
 - 15. ASTM
- C. Provide nameplates for all distribution equipment as specified herein and per Section 26 05 50.

1.02 SUBMITTALS

- A. The following data shall be submitted according to Section 01 33 00 and Section 26 01 00 and shall include but not be limited to:
 - 1. Physical dimensions, nameplate data, voltage, amperage, plan views, elevations, schematic wiring diagrams, bus capacities, circuit schedule, short circuit ratings, etc.
 - 2. The switchgear manufacturer shall provide a coordination study with settings of all over current protective devices. Over current protective devices shall be fully rated.
 - 3. Over current protective devices serving life safety systems and elevators shall be fully rated with selective coordination when applied in series with other devices.
 - 4. The switchgear manufacturer shall provide an ARC Flash study. Provide labels on all switchboards, panels, and other electrical equipment as required per NEC 110.16.
 - 5. The ARC flash and coordination studies shall be performed in SKM software. A working SKM file shall be provided as part of the study so the owner can update study in the future with SKM software.

- B. A ¼" scale dimensioned floor plan shall be provided with the switchgear submittals for all equipment rooms identifying actual size, clearance, access and spacing of the electrical equipment.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products in conformance with manufacturer's recommended practices as outlined in application installation and Maintenance Manuals.
- B. Each switchboard section shall be delivered in individual shipping splits for ease of handling. They shall be individually wrapped for protection and mounted on shipping skids.
- C. Inspect and report concealed damage to carrier within their required time period for repair or replacement.
- D. Store in a clean, dry space. Maintain factory protection and/or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.
- E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosures, and finish.

1.04 ELECTRICAL SERVICE

- A. Provide and install the building electrical service from the Power Company transformer(s) to the main service distribution equipment as shown on the Drawings. Any charges required by the Power Company for permanent power shall be included in this Contract.
- B. Coordinate all installation requirements with the Power Company prior to bid and include all trenching, conduits, vaults, equipment pads, current transformers, potential transformers, potential taps as required. Coordinate all Work with the Power Company.
- C. Provide conduit, C.T. enclosures, switchgear metering compartments, etc. as required by the Power Company for metering. Contractor shall coordinate all meter requirements with the Power Company prior to proceeding with this Work.
- D. The secondary service to the building shall be 120/208 volts, 3 phase, 4 wire, 60 Hertz AC.
- E. Provide (1) 1" conduit from each power company transformer to the telephone room and main service distribution equipment for pulse metering interface if available.

PART 2 - PRODUCTS

2.01 NOT USED

2.02 PANELBOARDS

- A. System Description
 - 1. Short circuit rating of panelboards shall be the interrupting rating of lowest rated device in the panel or application UL series for proper main and branch device combinations.
 - 2. Panelboards shall have a maximum of 42 protective devices per panel, including sub-feeders and excluding main overcurrent protective devices. For more than 42 devices, 2 or more panelboards are required.
 - 3. With 2 or more panelboards, sub-feed lug or thru-feed lugs shall be used in all by 1 section of each panelboard. Lugs shall have same capacity as incoming mains.
 - 4. Protective devices shall be molded case circuit breakers.
- B. Enclosure
 - 1. Boxes shall be a nominal 20 inches wide and 6 inches deep with wire bending space per the National Electric Code.
 - 2. Fronts shall be door-in-door construction reinforced steel with concealed hinges and concealed trim adjusting screws. Trim clamps are unacceptable.
 - 3. All door locks shall be corrosion proof Valox (or equal) with retractable latches. All door locks shall be keyed for a single key.
 - 4. Clean Lexan (or equal) directory card holders shall be permanently mounted on front door.
 - 5. All panelboard series ratings shall be prominently displayed on dead front shield.
 - 6. Interiors shall permit top or bottom incoming cables.
- C. Bus bars
 - 1. Bus bars shall be copper, phase sequenced, fully insulated and supported by high impact Noryl (or equal) interior base assemblies.
 - 2. Bus bars shall be mechanically supported by zinc finished galvanized steel frames to prevent vibration and damage from short circuits.
 - 3. Terminations shall be UL tested and listed and suitable for UL copper.
 - 4. Provide 1 continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors for bolt-on branch circuit breakers. Bus bars shall be rated as indicated in Drawings.
 - 5. Split solid neutral bus shall be plated and located in main compartment for all incoming neutral cables to be same length. 200% rated solid neutral shall be provided as indicated on the Drawings and shall be plated copper for non-linear load applications subject to harmonics. 200% rated solid neutral shall be self-certified by Manufacturer.
 - 6. Lugs shall be rated for 75 degree C terminations.
 - 7. Interiors shall be field convertible for top or bottom incoming feed. Main and sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.
 - 8. Log bodies shall bolt in place.
- D. Circuit Breakers

1. Molded case circuit breakers shall be bolt-in devices for 120/208V panels and 277/480V panels.
 2. All circuit breakers shall have thermal and magnetic trip elements in each pole.
 3. Multiple pole breakers shall have internal common trip crossbars for simultaneous tripping of each pole.
 4. Circuit breakers shall not be restricted to any mounting location due to physical size.
 5. All branch breakers 15 to 100 amperes shall be able to be mounted in any panel position for twin or double mounting without space penalty. Sum of ratings for 2 such twin mounted devices shall not exceed 180 amperes.
 6. Main and sub-feed circuit breakers may be vertically or horizontally mounted.
 7. Branch breaker panelboard connections shall be copper to copper.
 8. All panelboard terminations shall be rated as indicated in Drawings.
 9. All breakers shall have an over center mechanism and be quick make and quick break.
 10. All breakers shall have handle trip indication and a trip indicator in window of circuit breaker housing.
 11. Breaker handle and faceplate shall indicate rated ampacity.
 12. Circuit breaker escutcheon shall have standard ON/OFF markings.
 13. Main breakers shall be UL listed for use with: Shunt, Under Voltage, and Ground Fault Shunt Trips; Auxiliary and Alarm Switches; and Mechanical Lug Kits.
 14. Branch breakers shall be UL listed for use with: Shunt Trips, Auxiliary and Alarm Switches.
- E. Finish
1. Boxes shall be corrosion resistant, zinc finish galvanized.
 2. Fronts shall be powder finish painted ANSI 61 gray.
- F. Panels shall be manufactured by ABB-GE, Square D, Cutler-Hammer or Siemens.

2.03 DISTRIBUTION PANELBOARDS

- A. System Description
1. Equipment shall be indoor deadfront power panelboards for molded-case circuit breakers.
 2. Panelboards shall meet service entrance equipment where indicated on the Drawings.
 3. Panelboards shall have integrated short circuit rating. Fully rated panel rating is that of lowest rated device in panelboard. Series ratings are for the UL tested main-branch combination.
- B. Enclosures
1. Panel box shall be galvanized code gauge sheet steel with removable end walls.
 2. Enclosures shall be surface mounted.
- C. Fronts

1. Provide a four-piece front to cover wiring gutter and wiring access areas. Provide a lockable hinged door with semi-concealed hinges to cover access to circuit breakers.
2. Hinged door fronts, when specified, shall be provided with a lockable inner door with leaf hinges. An inner door shall cover the circuit protective devices and shall be able to be locked.
3. Door hinges shall be continuous piano hinges, welded to door(s) and bolted on front.
4. Door locks shall be Yale #511.

D. Interiors

1. Panelboard interior shall be symmetrically designed and assembled such that circuit protective modules are connected onto bus bar with positive gripping jaw assemblies and locked pressure connections.
2. Circuit-protective modules shall be designed for removal or replacement without disturbing adjacent protective devices and without removing main bus and branch circuit connections.
3. Interiors shall allow installation of molded-case circuit breakers in same panelboard.
4. Lugs shall be UL listed to accept solid or stranded copper cables. Lugs shall be bolted in place.
5. Panelboards shall be rated as indicated in Drawings. Main devices shall have maximum rating of 1200 amperes.
6. Panelboards shall have flat, stacked, vertically aligned bus bars.
7. Bus bars shall be copper. The bus bars shall have sufficient cross-sectional area to meet UL 67 temperature rise requirements through actual tests. The bus bars shall be standard density rated for 1000 amperes per square inch.
8. Bus bars shall be phase-sequenced and rigidly supported by high impact resistant, insulated bus supporting assemblies to prevent vibration or short circuit mechanical damage.
9. Neutral bus shall be fully rated and able to be located in either corner of enclosure at line end to facilitate conductor termination. Provide 200% rated neutral bus, if required by plans or another specification section.
10. All solderless terminations shall be suitable for copper UL listed wire or cable and shall be tested and listed in conjunction with appropriate UL standards. Terminations shall be rated for use with conductor ampacity as assigned in the NEC 75 degree C table.
11. Ground wire terminations shall be provided as an optional kit for installation by panelboard installer without voiding UL label.

E. Main and Branch Devices

1. Circuit breakers
 - a. Main and branch circuit breaker shall be quick-make, quick-break, and trip indicating, low voltage molded-case.
 - b. Circuit breaker case shall have ON/OFF and International I/O position indicators.
 - c. Breaker faceplate shall list current rating, UL and IEC certification standards, and AIC ratings.
 - d. Circuit breakers shall be factory sealed and shall be date coded on breaker case.

- e. Breakers shall be UL listed for reverse connection without restrictive line or load markings. Circuit breakers shall be able to mount in any operating position.
- f. 3-pole breakers with ampere ratings greater than 150 amperes shall have rating plugs.
- g. All circuit protective devices shall have the following minimum symmetrical current interrupting capacity of 18kA. Interrupting rating of breakers shall not be less than maximum short circuit current available at incoming line terminals as shown on plans.
- h. Breakers shall have UL listed series ratings, if specified in Drawings.
- i. Main breakers and lugs shall be convertible by installer for top or bottom incoming feed.
- j. Where indicated on the drawings, elsewhere in the specifications, or as required for coordination, the main breaker shall be provided with integral ground pick-up and delay settings and adjustable long time, instantaneous and short time settings.
- k. All main breakers and feeder breakers 1200A or larger shall be connected to an energy reducing maintenance switch with indicator light. Device shall comply with NEC Article 240.87.

F. Series Ratings

- 1. Panelboard series-connected ratings shall be attached to the panelboard enclosure.

G. Distribution panels shall be manufactured by ABB-GE, Square D, Cutler-Hammer or Siemens.

2.04 TRANSFORMERS

A. System Description

- 1. Power transformers shall be 2 winding dry type for general power and lighting applications. Transformers rated 1000 KVA or below shall be UL listed, DOE 2016 efficiency standard, and bear required UL Listing Mark.

B. Dry-type general purpose transformers shall be rated as indicated in Drawings.

C. Transformers shall use properly classified UL approved temperature ratings. Temperature rise ratings shall be in accordance with UL 506. Insulation ratings shall be as indicated in Drawings.

D. Transformers shall be UL recognized 200 degree insulation system and shall be designed so that under full load the average conductor temperature rise does not exceed 115 degrees C rise above a 40 degree C ambient and the enclosure does not exceed a 50 degree C rise at any point.

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

F. Transformers shall have sound levels equal to or lower than those established in latest revision of ANSI/IEEE C89.2 as shown in drawings.

- G. Enclosures shall meet UL 506 requirement for the following characteristics:
 - 1. Ventilation Openings;
 - 2. Corrosion Resistance;
 - 3. Cable Bending Space;
 - 4. Surface Temperature Rise;
 - 5. Wiring Compartment Temperature Rise;
 - 6. Terminations;

 - H. Transformer Construction
 - 1. Transformer cores shall be constructed of high grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities shall be kept well below core saturation point. Core laminations above 112.5 KVA shall be miter cut at core corners to reduce hot spots, core loss, current and sound level. Core laminations shall be clamped together with steel angles. Cores for transformers above 300 KVA shall be clamped using insulated bolts through core laminations to provide proper pressure throughout core length. Completed core and coil shall be bolted to enclosure base and isolated from base by rubber vibration-absorbing mounts. There shall be no metal-to-metal contact between core and coil and enclosure. Sound isolation systems requiring complete removal of all fastening devices is not acceptable.
 - 2. Transformer core shall be visibly grounded to enclosure by flexible grounding conductor meeting UL and NEC size requirements.
 - 3. Enclosure shall be constructed of heavy gauge steel.
 - 4. Coils shall be copper.

 - I. Load Taps
 - 1. Transformers shall have following high voltage load tap arrangements unless noted otherwise in plans:
 - a. Through 2 KVA – no taps;
 - b. Through 23 KVA – no taps;
 - c. 3 through 23 KVA 2 above, 2 below nominal 4, 2-1/2 percent taps voltage;
 - d. Through 500 KVA – 6, 2-1/2 percent taps, 2 above, 4 below nominal voltage.

 - J. Finish
 - 1. Finish shall consist of degreasing, phosphate cleaning, and electrodeposits ANSI gray enamel paint.

 - K. Transformers – standard shall be as manufactured by ABB-GE or Square D, Cutler-Hammer or Siemens.
- 2.05 BUSWAY (NOT USED)
- 2.06 DISCONNECT SWITCHES
- A. Switches shall be heavy-duty type. The switch blades shall be visible when the switch is OFF, and the cover is open. Lugs shall be front removable, and UL listed

for 75 degrees C conductor. Provide removable arc suppressor to facilitate easy access to line side up.

- B. Switches shall have provisions for a field installable electrical interlock.
- C. The switch operating mechanism shall be quick-make, quick-break.
- D. Provide padlock provisions for locking in the OFF position.
- E. Provide NEMA type enclosure suitable for the application (indoor, outdoor, wet or damp, corrosive, etc.). Type 3R enclosure shall contain no knockouts (supply watertight hubs).
- F. Enclosure shall have ON and OFF markings stamped on the enclosure.
- G. Switches shall be horsepower rated.
- H. Fused disconnect switches shall have rejection type fuse clips with dual element current limiting fuses of rating shown or required by the Manufacturer's nameplate of the equipment being supplied. The UL short circuit rating shall be 200,000 amps RMS SYM when used with Class R or J fuses.

2.07 FUSES

- A. Fuses shall have 200,000 Amp RMS SYS rating.
- B. Fuses for circuits 1 to 600 amperes shall be dual element, current limiting time delay (500% of rated current for minimum of 10 seconds) with separate overload and short circuit clearing chamber. Bussman "Low Peak" or equal by Littlefuse or Ferraz Shawmut. UL Class J.
- C. Fuses for circuits above 600 amperes shall be current limiting, time delay (500% of rated current for minimum of 4 seconds, clear 20 times rated current in 0/1 seconds or less). Bussman, "Hi-Cap" or equal by Littlefuse or Ferraz Shawmut. UL Class L.
- D. Provide one (1) set of spare fuses for each set of three (3). A maximum of three (3) sets of fuses is required to be provided for the same type and rating.

PART 3 - EXECUTION

1.01 GENERAL

- A. Clean all enclosures free of all foreign matter and dust.
- B. Remove all rust marks and repaint to new condition.
- C. Provide all necessary hardware to level and secure all switchgear.

- D. Provide engraved nameplates on all switchgear per Section 26 05 50 including but not limited to, switchboards, switchboard overcurrent protection devices, panelboards, distributor panelboards, disconnects, contactors, busway, busplugs.
- E. Provide a typewritten directory for all panelboards. Make spares in pencil.

1.02 FIELD TESTING

- A. Infra-red Testing
 - 1. After the electrical distribution system has been checked, adjusted, calibrated and under load just prior to substantial complete, it shall be subjected to an infra-red thermograph test by a NETA certified technician. The test shall be performed with a minimum load of 20% of the rating of the equipment/connection being tested. Load banks shall be supplied if necessary, to provide this load factor.
 - 2. Two (2) copies of the test report shall be provided to the Engineer upon completion of the test. Connections indicated having higher temperatures than acceptable shall be tightened or corrected as required. After corrections have been made, the connections shall be subjected to an additional thermograph test and rechecked to confirm the problem has been corrected.
 - 3. The following components and connections shall be included in the thermograph testing:
 - a. Service entrance
 - b. Switchboards
 - c. Switchboard main and feeder devices
 - d. Feeder taps
 - e. Busway cable terminations
 - f. Busway joints
 - g. Bustaps and busplug connections
 - h. Emergency distribution system
 - i. UPS system
 - j. Motor control centers
 - k. Distribution panels
 - l. Panelboards
 - m. Mechanical equipment connections (over 100 amps)
 - n. Transformers

END OF SECTION 262400

SECTION 262700 - DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide all devices specified herein, as indicated on the Drawings and as required to provide complete and operating systems.
- B. The wiring devices shall be designed, manufactured and tested in accordance with the latest version of the following standards:
 - 1. NEMA WD-1
 - 2. NEMA WD-5
 - 3. Underwriters Laboratories
 - 4. NEC

PART 2 - PRODUCTS

2.01 GENERAL

- A. The color of all devices, wall plates and coverplates shall be as selected by the Architect.

2.02 SWITCHES

- A. Wall switches, unless noted otherwise, shall be flush mounted, commercial grade 120/277-volt, 20-amp, toggle switches:
 - 1. Single Pole: Leviton No. 1221 Series or equal by Hubbell, P&S or Cooper
 - 2. Double Pole: Leviton No. 1222 Series or equal by Hubbell, P&S or Cooper
 - 3. 3-way: Leviton No. 1223 Series or equal by Hubbell, P&S or Cooper
 - 4. 4-way: Leviton No. 1224 Series or equal by Hubbell, P&S or Cooper
- B. Dimmer switches, unless specified otherwise in the Drawings or by the Architect, shall be Lutron Nova T-star series with wattage and type as required by the load and color/finish as selected by the Architect. Provide 3-way and 4-way dimmers where multiple dimmers as shown to control the same lights. Where on/off switches are indicated adjacent to dimmer switches they shall be ganged together, and the on/off switches shall also be Lutron Nova T-star series to match the look of the dimmer switches.
- C. Motor rated switches and switches indicated as pilot switches, unless noted otherwise, shall be flush mounted industrial grade, red pilot light "on" with overload protection as follows (note: wire per manufacturers recommendation):
 - 1. 120V, 20-amp Circuits – Hubbell HBL1221PL
 - 2. 277V, 20-amp Circuits – Hubbell HBL1221PL
 - 3. 120V, 30-amp Circuits – Hubbell HBL3031PL
- D. Key switches, unless noted otherwise, shall be flush mounted, commercial grade, 120/277V, 20 amp:
 - 1. Single Pole: Leviton No. 1221-2L Series or equal by Hubbell, P&S or Cooper

2. Double Pole: Leviton No. 1222-2L Series or equal by Hubbell, P&S or Cooper
 3. 3-Way: Leviton No. 1223-2L Series or equal by Hubbell, P&S or Cooper
 4. 4-Way: Leviton No. 1224-2L Series or equal by Hubbell, P&S or Cooper
- E. Wall switches behind house areas, unless noted otherwise, shall be commercial grade 120/277-volt, 20-amp, toggle switch Leviton No. 1221 Series or equal by Hubbell, P&S or Cooper.
- F. Timer switches, unless noted otherwise, shall be digital time switch 24VAC or 120/277VAC as required. Timeout adjustments from 5 minutes to 12 hours. Set timer in the field to 4 hours for equipment rooms and 30 minutes for all other areas. For timer setting greater than 2 hours select the visual flash option and audible sound option. Color shall match that selected for the switches unless noted otherwise.
- G. Wall mounted motion sensors, unless noted otherwise, shall be Wattstopper WS-250 for wall mounted at switch height and Wattstopper CI-200 for ceiling mounted. Provide power packs, relays, etc. as required to provide a complete system in each area. Color as selected by Architect. Adjust interval to 15 minutes at project completion unless noted otherwise. (Coordinate sensor type with lighting ballasts and provide accessories as required). Approved equal by Leviton or Cooper.

2.03 RECEPTACLES

- A. Receptacles shall be plastic, 2P, 3W, grounded as follows:
1. Duplex receptacles - for multi-outlet circuits, 125-volt, 15-amp rating Leviton 5262 Series or equal by Hubbell, P&S or Cooper
 2. Duplex receptacles - for dedicated, single-outlet circuits, 125-volt, 20-amp rating Leviton 5362 series or equal by Hubbell, P&S or Cooper
 3. Duplex isolated ground receptacle -125-volt, 20-amp rating Leviton 5362-IG series (provide color alternate of color for standard receptacles as selected by Architect) or equal by Hubbell, P&S or Cooper.
 4. Simplex (single) receptacles -125-volt, 20-amp rating Leviton 5361 series or equal by Hubbell, P&S or Cooper
- B. Ground Fault Interrupter Receptacles (GFCI) shall be plastic, 2P, 3W, 125-volt, 20-amp, self-protecting type Leviton 7899 series or equal by Hubbell, P&S or Cooper. Hospital GFCI receptacles shall be Leviton 7898-HG or equal by Hubbell, P&S or Cooper.
- C. Weather receptacles shall have a duplex GFCI receptacle as specified above with a gasketed extra-duty in-use weatherproof cover plate T&B CKLSVU or approved equal by P&S, Leviton or Hubbell.
- D. Hospital Grade receptacles shall be Leviton 8300 (duplex) and Leviton T7899 (GFCI) as applicable. Approved equals by Hubbell, P&S or Cooper.

- E. Controlled Devices shall be permanently marked (imprinted) with the word "controlled" and power symbol to clearly identify which receptacles are turned off when the workspace is vacant per ASHERA 90.1 2013. Leviton CR020 series or equal by Hubbell, P&S or Cooper.

2.04 COVERPLATES

- A. Coverplates shall be ??[plastic] midway size thermoplastic nylon Leviton PJ Series ??[steel] satin finish 302 stainless steel standard size (provide jumbo size for concrete and masonry walls) by Leviton or equal by Hubbell, P&S or Cooper.
- B. Provide multigang plates for devices shown at the same location. Coordinate gang configuration with the Architect where more than 3 devices are shown at one location.
- C. Coverplates for all back-of-house equipment rooms (i.e. mechanical, electrical, loading dock, service corridor, etc.) shall be stainless steel.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide appropriate outlet box for each device or multi-ganged devices.
- B. Provide plaster ring reducer for boxes larger than the device plate.
- C. Provide dimmer switch type and size to match load.
- D. Coordinate locations of all devices with the Architect and the interior detail Drawings.
- E. Coordinate cutting; obtain pre-cut openings from manufacturer for door switches, metal partitions and furniture mounted devices.
- F. In general, devices in finished spaces shall be flush mounted. Verify the requirements of all spaces with the Architect.
- G. Each device shall have a coverplate as is appropriate for the application. Coverplates shall be installed true and plumb with building lines, mortar joints and architectural features.
- H. Mount receptacles and special systems outlets vertical and 18" above the finished floor to the device centerline, unless noted or required otherwise.
- I. Mount switches vertical and 48" above the finished floor to the device centerline and 6" from a door strike, unless noted or required otherwise.
- J. All exterior devices shall be provided with a weatherproof cover/enclosure. Exterior receptacles shall be GFCI type.

- K. Coordinate mounting heights for devices indicated to be mounted over counter with the Architect.
- L. Provide a green insulated bonding jumper for all grounded devices and bond to the outlet box.
- M. Each outlet used as a junction box, or for future device or fixture, shall be fitted with a blank coverplate to match other device coverplates.
- N. Floor outlets shall be of the necessary type suitable for the application and installed per the manufacturer's recommendation. Fire ratings shall be maintained. Where the installation of a specified or required floor box affects the elevated slab/floor fire rating, the necessary fire assembly (approved by the Architect) shall be constructed below the slab.
- O. Do not locate junction boxes or voice/data conduit stub downs for poke-thru devices above a non-accessible ceiling. In these cases, extend the poke-thru conduit to an accessible ceiling.

END OF SECTION 262700

SECTION 26 29 00 - MOTOR CONTROLS AND WIRING

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide all equipment, materials, tools and labor to provide a complete system for motor operation. Refer to other related Sections of Divisions 21, 22 and 23 and the Mechanical, Electrical and Plumbing Drawings.
- B. A Motor starter shall be provided by Division 26 for each motor except for those specified in Divisions 21, 22 or 23 to be furnished by that Division. All motor starters not integral to the equipment served shall be installed and connected by Division 26.
- C. All low voltage control wiring shall be provided by Division 21, 22 or 23 unless specifically noted otherwise on the Drawings.
- D. Provide 120-volt line voltage for controls as required. Provide 120 volt to all line voltage motor operated dampers. Provide fire alarm connections to all fire and smoke dampers. Coordinate with Divisions 21, 22 and 23.

PART 2 - PRODUCTS

2.01 MOTOR STARTERS

- A. All motor starters shall be UL listed.
- B. The motor starters shall be front wired with all terminals accessible for wiring directly from the front. All contacts shall be solid silver cadmium oxide alloy. Bare copper or silver-flashed type shall not be permitted. Operating coils shall be pressure molded and so designed that if accidentally connected to excessive voltage they will not expand, bubble, or melt. When a coil fails under over-voltage conditions, the motor controller shall definitely drop out and not freeze the contacts in the "ON" position.
- C. All three-phase full voltage magnetic motor starters shall have overload protection in all three phases. All single-phase full voltage magnetic motor controllers shall have overload protection in ungrounded phases. All two-speed full voltage magnetic motor controllers shall have overload protection in all six (6) legs of the controller. Overload relays shall be furnished for each phase and shall be of the hand-reset trip-free variety so that blocking the reset mechanism in the reset position will not prevent the motor controller from dropping out if the motor is overloaded. This specifically excludes those overload relays which change to automatic reset from hand-reset when the reset mechanism is blocked. Accidentally depressing the reset button or mechanism will not shut-off the motor. Overload relays shall NOT be field convertible from hand to automatic reset type.

Overload relays shall be the thermal bi-metallic type. Circuit breaker disconnects for combination motor starters shall be magnetic only.

- D. Motor starters shall be provided with auxiliary dry contacts as follows:
 - 1. NEMA size 3 and larger: two (2) N.O. and two (2) N.C.
 - 2. NEMA size 2: two (2) N.O. and one (1) N.C.
 - 3. NEMA size 1 and 0: one (1) N.O. and one (1) N.C.
- E. Provide necessary terminal strips and relays as required for interface with the motor operation, the Building Automation System, Fire Alarm System, and Fireman's Override Panel (if applicable). Coordinate with Division 23.
- F. In general, motor starter enclosures shall be NEMA Type 1, general purpose unless exposed to the weather or unless otherwise specified on the Drawings. Motor starters exposed to the weather shall be NEMA Type 3R watertight.
- G. Generally, holding coils in full voltage magnetic motor starters shall be suitable for use on 120-volt, AC control voltage. Each controller shall have a control power transformer with primary and secondary fuses. Control power transformer shall have at least 50 VA capacity over and above the standard capacity required for holding coil and LED pilot light duty. Sizing of control transformers shall be coordinated with Division 23.
- H. Two-speed motor starters for two-speed motors shall have "decelerating relay" between high and low speed.
- I. Each motor starter shall be equipped with a handoff-automatic or start-stop push-button, as required by Division 15. Provide green LED light for "RUNNING", red LED light for "STOPPED". Provide amber LED light reading "TRIPPED" and interfaced with overload relay alarm contacts. Two-speed motor starters shall have "fast-slow" LED lights as well as a fast-slow selector switch in conjunction with the HOA as required by Division 23. LED lights will be operated by an interlock in the motor starters not placed across the operating coil. In addition to the holding interlock and LED light interlocks, each starter shall have four extra interlock contacts – two normally open and two normally closed.
- J. Where indicated on the Drawings at individual motor starters, provide surge protection on the load side of the motor controller. Surge protection shall consist of one protective capacitor and one secondary arrestor.
- K. Acceptable manufacturers are ABB-GE, Square 'D', Cutler-Hammer, Siemens, Allen-Bradley.

2.02 MOTOR CONTROL CENTERS

- A. A combination starter shall be provided in the motor control center for each motor and shall be plug-in circuit breaker with voidable cover interlock. Provide provision for padlocking the cover and operating handle. Provide interrupting capacity as required, minimum 65KA RMS SYM.

- B. Motor starters shall be mounted in individual compartment below the breaker associated with it.
- C. Provide a mechanical interlock to prevent opening the starter compartment door unless it is in the "off" position.
- D. Provide an individual control circuit transformer in each section of the motor control center with fused secondary.
- E. Provide a control terminal strip in the Motor Control Center. The control wiring from these terminal strips, external to the Motor Control Center, to the respective control device, shall be included in Division 21, 22 or 23.
- F. Acceptable manufacturers are ABB-GE, Square 'D', Cutler-Hammer, and Siemens. All circuit breakers, motor starters, push buttons and pilot lights shall be of the same manufacturer as the electrical distribution equipment (switchboards, panelboards, etc.).

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All motor starters shall be installed by Division 26 unless an integral part of a piece of equipment.
- B. Provide all power wiring to motors unless pre-wired as part of a packaged unit.
- C. Provide line voltage power wiring through a control device (i.e. fire stats, thermostat, aqua stat, smoke dampers) where required. Provide duct smoke detectors or in-duct smoke detectors at all smoke dampers. Coordinate with Divisions 21, 22 and 23.
- D. Where multiple mechanical terminal units (e.g. PIU's) containing multi-phase heating elements and single-phase motors are connected together on the same multi-phase homerun/circuit, the single-phase motors shall be connected to alternate phases to balance the load. Coordinate with Division 23. Provide a neutral conductor of equal size to the phase conductors unless noted otherwise on the Drawings.
- E. Where multiple mechanical terminal units (e.g. PIU's) containing multi-phase heating elements and single-phase motors are connected together on the same multi-phase homerun/circuit, each unit shall require power side fusing. Electrical Contractor shall provide fused disconnect if unit is not provided with unit power side fusing. Coordinate with Division 23.
- F. Motor controllers or industrial control panels of multi-motor and combination load equipment shall be marked with a short circuit current rating. The available short circuit current and the date the short circuit current calculation was performed shall be documented and made available to those authorized to inspect the installation. Electrical Contractor shall provide disconnect with current limiting

fuses where the available short-circuit current exceeds its short-circuit current rating. Coordinate with Division 23.

END OF SECTION

SECTION 264304 - SURGE PROTECTIVE DEVICE

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The Surge Protection Device (SPD) covered under this section includes all service entrance type surge protection devices suitable for use as Type 1 or Type 2 devices per UL1449 3rd Edition, applied to the line or load side of the utility feed inside the facility.
- B. An SPD located at Service Entrance (see plans for additional SPD devices).
- C. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to finish and install surge protection devices.

1.02 QUALITY ASSURANCE

- A. Reference Standard: Comply with the latest edition of the applicable provisions and recommendations of the following, except as otherwise stated in this document:
 - 1. UL 1449 4th Edition with latest revisions.
 - 2. UL 1283.
 - 3. ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
 - 4. ANSI/IEEE C62.45, Guide for Surge Testing for equipment connected to Low-Voltage AC Power Circuits.
 - 5. UL96A
 - 6. IEEE 1100 Emerald Book.
 - 7. National Fire Protection Association (NFPA 70: National Electrical Code).

1.03 SUBMITALLS/QUALITY ASSURANCE – SUBMIT THE FOLLOWING:

- A. Package must include show drawings complete with all technical information, unit dimensions, detailed installation instructions, maintenance manual, recommended replacement parts list and wiring configuration.
- B. Copies of Manufacturer's catalog data, technical information and specifications on equipment proposed for use.
- C. Copies of documentation stating that the Surge Protection Device is listed by UL to UL1449 3rd Edition, category code VZCA.
- D. Copies of actual let through voltage data in the form of oscillograph results for both ANSI/IEEE C62.41 Category C3 (combination wave) and B3 (Ring wave) tested in accordance with ANSI/IEEE C6245.
- E. Copies of Noise Rejection testing as outlined in NEMA LS1-1992 (R2000) Section 3.11. Noise rejection is to be measured between 50kHz and 100MHz verifying the devices noise attenuation. Must show multiple attenuation levels over a range of frequencies.

- F. Copies of test reports from a recognized independent testing laboratory, capable of producing 200kA surge current waveforms, verifying the suppressor components can survive published surge current rating on a per mode basis using the ANSI/IEEE C62.41 impulse waveform C3 (8 x 20 microsecond, 20kV/10kA). Test data on an individual module is not acceptable.
- G. Copy of warranty statement clearly establishing the terms and conditions to the building/facility owner/operator.

PART 2 – PRODUCTS

2.01 APPROVED MANUFACTURER:

- A. Current Technology – Transguard3 or TG3 Series 200kA per mode surge rating or approved equal by Liebert, ABB-GE.

2.02 MANUFACTURED UNITS/ELECTRICAL REQUIREMENTS

- A. Refer to drawing for operating voltage, configuration and surge current capacity per mode for each location, or you may list locations and information here.
- B. Declared Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL1449 3rd Edition, section 37.7.3. MCOV values claimed based on the component's value or on the 30-minute 115% operational voltage test, section 38 in UL1449 will not be accepted.
- C. Unit shall have no more than 10% deterioration or degradation of the UL1449 3rd Edition Voltage Protection Rating (VPR) when exposed to a minimum of 5,000 repeated category C3 (20kV/10kA) surges. The SPD manufacturer must provide a test report validating the repetitive surge test was performed.
- D. Protection Modes UL1449 3rd Edition VPR (6kV, 3kA) for grounded WYE/delta and High Leg Delta circuits with voltages per the contract documents shall be as follows and comply with test procedures outlined in UL1449 3rd Edition section 37.6:

System Voltage	Mode	MCOV	B3	C3 Comb.	UL 1449
			Ringwave 6kV, 500A	Wave 20kV, 10kA	Third Edition VPR Rating
120/240, 120/208	L-N	150	490	980	700
	L-G	150	570	980	700
	N-G	150	640	1170	700
	L-L	300	500	1600	1200
277/480	L-N	320	450	1420	1200
	L-G	320	540	1540	1200
	N-G	320	570	1600	1000
	L-L	552	530	2600	2000

- E. Electrical Noise Filter - each unit shall include a high-performance EMI/RFI noise rejection filter with a maximum attenuation of 54dB per MIL-STD-220B.
 - 1. SPD shall include an EMI/RFI noise rejection filter for all L-N modes as well as a removable filter in the N-G mode.

- F. Integral Disconnect Switch
 - 1. The device shall have an optional NEMA compliant safety interlocked integral disconnect switch with an externally mounted metal manual operator.
 - 2. The switch shall disconnect all underground circuit conductors from the distribution system to enable testing and maintenance without interruption to the facility's distribution system.
 - 3. The switch shall be rated for 600Vac.
 - 4. The SPD device shall be tested to UL1449 3rd Edition listed with the integral disconnect switch and the UL1449 VPR ratings shall be provided.
 - 5. The integral disconnect switch shall be capable of withstanding, without failure, the published maximum surge current magnitude without failure or damage to the switch.
 - 6. The line side of the integral disconnect shall be blocked off so that when the SPD is opened there is no direct access to the voltage present on the line side of the disconnect.

- G. The UL1449 Voltage Protective Rating (VPR) shall be permanently affixed to the SPD unit.

- H. The UL1449 Nominal Discharge Surge Current Rating shall be 20kA.

- I. The SCCR rating of the SPD shall be 200kAIC without the need for upstream over current protection.

- J. The SPD shall be listed as Type 1 SPD, suitable for use in Type 1 or Type 2 applications.

- K. The SPD shall have the following monitoring options.
 - 1. Time Date stamp, duration and magnitude for the following power quality events (sags, swells, surges, dropouts, outages, THD, frequency, Volts RMS per phase)
 - 2. SPD monitoring shall track surge protection and display it as a percentage.
 - 3. SPD shall provide a surge counter with three categories to be defined as Low Level surge (100A-500A) Medium Level surge (500A-3,000A) High Level surge (>3,000A)
 - 4. Remote communications via ModBus or Ethernet

PART 3 –EXECUTION/INSTALLATION

- 3.01 The SPD manufacturer's technician shall perform a system checkout and start-up in the field to assure proper installation, operation and to initiate the warranty of the system. The technician will be required to do the following:

- A. Verify voltage clamping levels utilizing a diagnostic test kit, comparing factory readings to installed readings.
 - B. Verify N-G connection.
 - C. Record information to a product signature card for each product installed.
- 3.02 Unit may be installed on either the line or load side of the main service disconnect. If installed on the line side unit shall be installed with an integral disconnect. If installed on the load side the unit shall be installed on the largest breaker size available. If installed lead length exceeds 5' installer shall use a low impedance (HPI) cable to reduce the lead lengths effect on the installed performance of the SPD.

PART 4 –PRODUCT WARRANTY

- 4.01 Warranty on defective material and workmanship shall be for 15 years.
- 4.02 Copy of Warranty to be sent with submittal.

END OF SECTION 264304

SECTION 265000 - LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide lighting fixtures complete with all lamps as specified on the Electrical, Architectural, Interior and Lighting Designer Drawings. Provide all supports, brackets, connectors, materials, tools, wiring, controls and labor to provide a complete and operating lighting system.
- B. All blemished, damaged or unsatisfactory fixtures shall be replaced in a satisfactory manner as directed by the Architect.
- C. Where a fixture type designated has been omitted, cannot be determined or is in conflict with other Drawings or Specifications, request a clarification from the Architect, prior to bid, and provide suitable fixture type as directed.
- D. All lamps shall be operating at project completion and for a period of six (6) months after the final acceptance by the Owner.
- E. Confirm exact locations of lighting fixtures with the Architectural Reflected Ceiling Plan and mechanical equipment above or on the ceiling.
- F. All recessed lighting fixtures shall match the ceiling type and be tested and certified by the fixture manufacturer for the type of mounting.

1.02 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Handle lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures; replace and return damaged units to equipment Manufacturer.
- B. Store lighting fixtures in clean, dry space. Store in original cartons and protect from dirt, physical damage, weather, and construction traffic.

1.03 SUBMITTALS

- A. The following submittal data shall be furnished according to Section 01 33 00 and Section 26 01 00 and shall include but not be limited to:
 - 1. Lighting fixtures complete with physical dimensions, materials, connector details, voltage, current, installation details, air handling capability, etc.
 - 2. Lamps complete with base or pin configuration, lumen rating, life expectancy, color temperature, starting characteristics, etc.

PART 2 - PRODUCTS

2.01 LIGHTING FIXTURES

- A. Base bid lighting fixtures shall be based on manufacturer and descriptions listed. Alternate fixture manufacturers not specified and proposed by the Contractor shall be submitted for approval prior to base bid.
- B. Fixtures are designated on the Drawings by "type" as indicated by a letter that corresponds to a lighting fixture description and specification on the lighting fixture schedule.
- C. Each lighting fixture shall comply with NEC Article 410, Energy Independence & Security Act, local codes and the authority having jurisdiction.
- D. Provide a lighting fixture complete with lamps, ballasts and required accessories for each lighting fixture shown. Provide all mounting and trim hardware to suit the specific installation and location.
- E. All lighting fixtures shall bear a U.L. label.
- F. Where fixtures are specified with acrylic lens, provide virgin acrylic with 0.125-inch thickness.
- G. Exit lighting fixtures shall meet the requirements of all federal, state and local codes.

2.02 LAMPS

- A. Incandescent A-lamps shall be inside frosted, and 130 volts rated unless noted otherwise. Par and reflector type lamps shall be 130 volts rated.
- B. All lamps shall be as specified on the Lighting Fixture Schedule.
- C. Fluorescent lamps in general shall be T8, 48-inch length with initial lumens of 2,950 at 32 watts and an average life of 20,000 hours. If a color is not designated on the Drawings, then provide 3500K color lamps. Ballast and lamps shall be compatible.
- D. Acceptable manufacturers are General Electric, Osram-Sylvania or Philips.

2.03 LAMP HOLDERS

- A. For incandescent, provide porcelain body and nickel-plated brass socket, prelubricated with silicone compound.
- B. For fluorescent, provide white urea plastic body and silver-plated phosphor bronze or beryllium copper contacts. Fluorescent lamp sockets with open-circuit voltage over 300 volts shall be safety type and designed to open circuit when lamp is removed.
- C. For compact fluorescent lamps, provide molded thermoplastic body with copper alloy contacts and stainless-steel retainer clips. Provide pin configuration to match lamps.

- D. For high intensity discharge, provide porcelain body and nickel-plated brass socket, prelubricated with silicone compound. Medium base sockets shall be 4 KV pulse rated.

2.04 BALLASTS

A. General

1. All ballasts shall be UL listed and CBM certified. Ballasts shall be CSA certified where applicable.
2. Ballast shall be approved for operating with specified lamp. Ballast shall provide normal rated lamp life as stated by acceptable lamp manufacturer.
3. Ballast shall be suitable to operate on the voltage system they are connected to and maintain correct lamp operation with 10% fluctuation of rated input voltage with no damage to ballasts or lamps.
4. Ballast shall have the lowest sound rating available for the lamps specified. Replace noisy ballasts as directed by Engineer at no cost to the Owner.
5. Ballast shall contain no PCBs.
6. Ballasts shall be identical within each fixture type. All ballasts within the same luminaire shall be from the same manufacturer.
7. Ballast shall support a sustained short to ground on open circuit of any output leads without damage to the ballast and without blowing fuses either inside the ballast or in line with the ballast.
8. Ballast shall be suitable to operate in:
 - a. Indoor heated or air-conditioned spaces: 50°F to 150°F ambient.
 - b. Outdoor or in unheated spaces: 0°F to 105°F.
 - c. Un-air-conditioned spaces: 50°F to 150°F at rated life in pendant mounted industrial type fixture.
 - d. Recess mounted fixtures: in maximum 140°F ceiling cavity.
 - e. With fire-rated covering, clear air space between fixture and covering minimum of 3 inches.
9. Provide ignitor shut-off device for CSA, HX and R ballast similar to Advance LISOD1 series. The device shall disable the ignitor after 15 minutes of pulsing in cases when lamp has failed or has been removed from socket.
10. Ballast for T-4 and T-5 lamps shall have lamp fault interrupter for end of life failure.
11. Manufacturer shall have been manufacturing ballasts for at least 5 years.

B. Fluorescent Ballast

1. Ballast shall be high frequency and operate lamps at a frequency above 25 KHz with less than 2% lamp flicker.
2. Provide rapid start 0.99 power factor ballast, except as noted, with required voltage and frequency.
3. Ballast shall be UL listed Class P with integral resetting thermal protector and be suitable for use indoor or Type 1 outdoor application.
4. Ballast case temperature shall not exceed 90°C.
5. Ballast shall have a ballast factor of greater than .875.
6. Ballast shall comply with Federal Communications Commission Part 18C limits for electromagnetic interference and radio frequency interference for non-consumer equipment.

7. Ballast shall provide transient immunity as specified by ANSI C62.41, Category A (formerly IEEE 587, Section B).
 8. Ballast shall have lamp current crest factor of less than 1.7.
 9. Total harmonics distortion shall be less than 10%.
 10. Third harmonic distortion shall be less than 6%.
 11. Ballast shall internally limit in-rush current to not exceed 30 times normal operating current for duration of 5 milliseconds.
 12. Manufacturer shall provide 5-year written warranty against defects in material or workmanship, including replacement labor cost.
 13. Acceptable manufacturers are Magnetek, Motorola, Osram/Sylvania and Advance.
- C. T-8 Electronic Fluorescent Dimming Ballast
1. Ballast shall meet criteria for electronic fluorescent ballasts. See above.
 2. Smooth continuous dimming ranges from 100%-1%.
 3. Power factor greater than .90.
 4. Total harmonic distortion less than 20%.
 5. No visible lamp flicker over entire dimming range.
 6. Ballast shall be capable of striking lamps at any light level without first flashing to 100% output.
 7. Ballast shall be UL listed for operating specified lamps.
 8. Ballast shall be inaudible over entire dimming range.
 9. Acceptable manufacturer is Lutron.
- D. T-4 and T-5 Compact Fluorescent Electronic Dimming Ballast
1. Ballast shall meet criteria for electronic fluorescent ballasts. See above.
 2. Smooth continuous dimming ranges from 100%-5%.
 3. Power factor greater than .90.
 4. Total harmonic distortion less than 20%.
 5. No visible lamp flicker over entire dimming range.
 6. Ballast shall be capable of striking lamps at any light level without first flashing to 100% light output.
 7. Ballast shall be UL listed for operating specified lamps.
 8. Ballast shall be inaudible over entire dimming range.
 9. Acceptable manufacturer is Lutron.
- E. High Intensity Discharge
1. Provide constant wattage autotransformer (CWA) or high reactance autotransformer high power factor (HX-HPF) type ballast with power factor greater than .90 except as noted.
 2. Ballast shall be designed with Class N insulation.
 3. Drop out voltage shall be not less than 70% of nominal.
 4. For indoor commercial application:
 - a. Provide NEMA rated AA@ sound rating.
 - b. Ballast shall comply with Federal Communications Commission Part 18C limits for electromagnetic interference and radio frequency interference.
 - c. Ballast shall provide immunity as specified by ANSI C82-4.
 5. Acceptable manufacturers are Magnetek, Osram/Sylvania, Advance, and Valmont.
- F. Drivers for LED Fixtures

1. Electronic Driver for LED Fixtures: Comply with UL 1310 Class 2 requirements for dry and damp locations. Include the following features unless otherwise indicated:
 - a. Rated for 50,000 hours of life, unless otherwise noted.
 - b. Sound Rating: Class A.
 - c. Total Harmonic Distortion Rating: 15 percent or less.
 - d. Current Crest Factor: 1.5 or less.
 - e. 0-10V Dimming Standard (Step Dimming does not qualify)

2.05 EMERGENCY BATTERY LIGHTING

- A. Lighting fixtures indicated on the drawings to be provided with an emergency battery ballast shall provide emergency lighting by using standard fluorescent lamp or lamps and an emergency battery ballast. The ballast shall consist of a field replaceable high temperature, maintenance free nickel cadmium battery, charger and electronic circuitry contained in one metal case. Provide a solid state charging indicator light to monitor the charger and battery, double pole test switch and installation hardware. The battery ballast shall provide power to the fluorescent lamp upon failure of the normal supply to the fixture.
- B. The test button and indicator light shall be integral in the fixture reflector and shall be positioned within or on the surface of the fixture so as to be accessible and identifiable.
- C. Under normal mode the battery ballast shall keep the batteries at full charge. Upon loss of normal power, the battery ballast shall operate the fluorescent lamp or lamps for 90 minutes.
- D. Battery recharge time shall not exceed 16 hours to fully recharge and shall not exceed 225 milliamperes charging current.
- E. The lumen output of the lamp or lamps powered by battery unit shall be not less than 1100 lumens initially for a four-foot fluorescent lamp.
- F. The battery ballast shall meet or exceed all the requirements set forth in UL924 "Emergency Lighting and Power Equipment" and shall be UL listed for installation on top of or remote from the fixture. Emergency illumination shall meet or exceed the requirements set forth in the National Electric Code, Life Safety Code and UL 90-Minute Requirements.

2.06 LED FIXTURES

- A. Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.
- B. Include the following features unless otherwise indicated:
 1. Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
 2. Each luminaire shall be rated for a minimum operational life of 50,000 hours utilizing a minimum ambient temperature of (25°C).

3. Light Emitting Diodes tested under LM-80 Standards for a minimum of 12,000 hours.
4. Color Rendering Index (CRI) of 82 at a minimum.
5. Color temperature shall be as indicated in the schedule.
6. Rated lumen maintenance at 70% lumen output for 50,000 hours, unless otherwise indicated.
7. Fixture efficacy of 100 Lumens/Watt, minimum.
8. 5-year luminaire warranty, minimum.
9. Photometry must comply with IESNA LM-79.
10. The individual LEDs shall be constructed such that a catastrophic loss of the failure of one LED will not result in the loss of the entire luminaire.
11. Luminaire shall be constructed such that LED modules may be replaced or repaired without the replacement of the whole fixture.

Technical Requirements

1. Luminaire shall have a minimum efficacy of 60 lumens per watt. The luminaire shall not consume power in the off state.
2. Operation Voltage: The luminaire shall operate from a 50 HZ to 60 HZ AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
3. Power Factor: The luminaire shall have a power factor of 0.9 or greater.
4. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 15 percent.
5. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.

C. Thermal Management

1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
2. The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.
3. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
4. The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.

PART 3 - EXECUTION

3.01 GENERAL

- A. Locations on the Drawings are diagrammatic. Verify exact locations with Architectural Reflected Ceiling Plans and coordinate space conditions with other trades.
- B. Modify locations in mechanical equipment rooms to suit the conditions of the mechanical equipment while maintaining a sufficient and uniform lighting level equal to that provided by the layout shown on the Drawings.
- C. Fixtures of the same type and in the same ceiling shall have lamps, socket assembling, and door hinges oriented in the same direction.

- D. Reflector cones, baffles, aperture plates, light controlling element for air handling fixtures and decorative elements shall be installed after completion of ceiling tiles, painting and general cleanup.
- E. Target and focus adjustable lighting fixtures after regular working hours and before building acceptance. Permanently indicate targeting on fixture and provide positive locking devices to preclude mis-focus relamping. Target and focus in the presence of the Architect and Lighting Designer.
- F. Relamp all incandescent and low-voltage fixtures immediately prior to Owner's acceptance of building. Replace non-operating, damaged or darkened fluorescent and high intensity discharge lamps immediately to Owner's acceptance of building.
- G. Clean all fixture reflectors, lenses, louver, decorative accessories and lamps immediately prior to Owner's acceptance of building. Destaticize plastic lenses and diffusers after cleaning.
- H. Lighting fixtures mounted within, under, on or integral with millwork shall be given special consideration. Fixture counting and sizes shall be coordinated with the applicable space and adjusted accordingly. This coordination shall occur prior to ordering fixtures. Refer to Architectural Drawings for details.

3.02 SUPPORT OF LIGHT FIXTURES

- A. Support directly from building structure, any lighting fixture which weighs in excess of the capacity of the suspended ceiling on which it is installed. Support each such fixture with the quantity of threaded rods or fixture support wires required to prevent fixture warping; however, provide no less than two rods or wire per fixture.
- B. Outlets, which are recessed in a suspended ceiling and support the weight of surface-mounted or suspended fixtures, shall be supported from a channel spanning and secured to the ceiling support system. Support each end of the channel with a fixture support wire attached to structure.
- C. Installation in grid-type suspended ceiling:
 - 1. Support each corner of a grid opening, in which a lay-in fixture is located, with a fixture support wire attached to structure. Provide a support clip, securely fastened to the ceiling grid, at or near each corner of each lay-in fixture.
 - 2. Support fixtures, which are smaller than the ceiling grid opening, and which are recessed in the acoustical panel, with at least two metal channels spanning, and secured to, the ceiling grid. Support each end of each channel or each corner of the grid opening with a fixture support wire attached to structure. Do not support fixtures by ceiling acoustical panels.
- D. Provide additional supports as required by local codes and seismic zone.

END OF SECTION 265000