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SECTION 260000 – BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Applicable provisions of Bidding Requirements and Division 1 General Requirements apply to work of this Section.
- B. Should a conflict arise between this section and other Sections, the General and Supplementary Conditions of Division 1 shall take precedence.
- C. The word "Contractor" as used in these specifications shall be held to mean the person, firm or corporation contracting to do the herein described work.
- D. The submittal of a proposal carries with it the agreement to all items and conditions referred to in the specifications and accompanying drawings.

1.2 RULES AND REGULATIONS

- A. The rules, regulations, ordinances of all applicable governing bodies in force at the time of execution of the Contract shall become a part of these specifications. These shall include the requirements of state, county, city and also the requirements of local utility companies.
- B. All material furnished and work performed shall be in compliance with the latest applicable versions of the following codes, including local ordinances and amendments:
 - International Building Code - 2015
 - National Fire Protection Association NFPA
 - National Electrical Code - 2014
 - OSHA Requirements
 - International Energy Conservation Code - 2015
 - Americans with Disabilities Act, Standards for Accessible Design - 2010
- C. All electrical material used on this project must be UL listed and labeled.
- D. Where a conflict exists between the applicable codes, the plans and the specifications, the one shall be followed that results in the higher quality, most expensive and most complete installation.
- E. Install electrical equipment, devices and appurtenances in accordance with applicable standards and NECA 1-2010, "Standard Practice of Good Workmanship in Electrical Contracting."

1.3 PERMITS, LICENSES AND INSPECTION FEES

- A. This subcontractor shall obtain and pay the cost of all fees, permits or licenses that may be required for the performance of the work described herein.

1.4 PLANS AND SPECIFICATIONS

- A. The specifications and the accompanying drawings plans (architectural, site, structural, mechanical, electrical, fire protection and plumbing) are mutually explanatory and anything described or shown on one, but not on the other, shall be considered as if shown or described on all. The intention of the drawings and specifications is to provide complete functioning systems in every respect. Furnish all material and equipment and perform all labor to achieve this intent, whether or not such material or equipment is indicated herein. Whenever the term "provide" is used, it shall mean "furnish and install."

- B. Data given herein and on the drawings is as exact as could be secured. Their absolute accuracy is not guaranteed. Obtain and verify exact locations, measurements, levels, space requirements, etc., at the site, and adapt the work to actual conditions at the building as constructed.
- C. The drawings shall be considered schematic and are not intended to indicate all required materials. Conduit, wiring, equipment, etc., shall be installed so all items clear the structure and other building elements and maintain appropriate clearances for access, service and maintenance.
- D. Some of the details on the drawings are schematic or diagrammatic. These details are not intended to show all materials, etc., required to achieve the arrangement shown. Adapt these details to the actual conditions of the job.
- E. Routing of conduit and location of equipment and other devices are shown on plans for general guidance. This Contractor shall coordinate his work with other Contractors and shall provide necessary deviations in routing as far as 10 feet from those shown to provide systems as specified or implied, without interference and pursuant to these requirements at no additional cost to the Owner, Architect or Engineer.
- F. Contractor shall not scale the drawings. Refer to architectural and structural drawings for building construction and dimensions and to room finish schedule on architectural drawings for material, finish and construction method of walls, floors and ceilings in order to insure proper rough-in and installation of contractor's work.
- G. Changes, modifications or variations to the plans and specifications will be issued by the Engineer in writing.
- H. Coordinate arrangement, mounting and support of electrical equipment.
 - 1. To allow maximum possible headroom, unless specific mounting heights are indicated.
 - 2. To provide for ease of disconnecting equipment with minimum interference to other installations.
 - 3. To allow right-of-way for piping and conduit installed at slopes.
 - 4. So connecting raceway will be clear of obstructions and of the working and access space of other equipment.
- I. All mechanical, electrical, plumbing, fire protection, and HVAC work shall be coordinated by that contractor and any correction to any of the above work shall be at that contractor's expense.

1.5 DISCREPANCIES OR OMISSIONS

- A. During the bidding period, any discrepancies or omissions in any of the documents or any doubt as to their meaning, should be reported to the Engineer who will, time permitting, issue a written instruction in the form of an addendum to all bidders of record. The Engineer will not be responsible for any oral explanations or interpretations of the documents.
- B. During construction, should a discrepancy or omission be found, it shall be brought to the attention of the Engineer at once for resolution.
- C. No changes in contract price will be allowed for minor changes in layout or location required to avoid interferences, obstructions, etc. Contract price changes will be considered only for changes in the scope of the project requirements. All such scope changes and price revisions must be authorized in writing.
- D. If discrepancies are found within the contract documents, the most demanding requirement shall take precedence unless otherwise agreed by the engineer in writing.

1.6 VISITING THE SITE

- A. Before submitting a bid, visit the site and become acquainted with the conditions under which the work will be performed.
- B. Failure to fully understand the existing site conditions under which the work is to be performed will not be justification for additional compensation after the award of the contract.

1.7 SHOP DRAWINGS

- A. Contractor shall submit shop drawings in compliance with the General and Special Conditions. Contractor shall field verify exact locations, measurements, and space availability at the site, etc. prior to fabricating materials and shall notify the Engineer of discrepancies in writing.
- B. The Contractor shall submit copies of all required Shop Drawings and material and equipment lists.
- C. Submittals shall be transmitted to SSC Engineering as paper documents, electronic documents via email attachments, or electronic documents via FTP file transfers.
 - 1. All submittals shall include a transmittal form identifying the project name, date, contents of submittal package, and names of subcontractor, manufacturer, and supplier.
 - 2. On an attached separate sheet clearly identify deviations from requirements in the Contract Documents, including minor variations and limitations.
 - 3. Paper submittals shall be sent to

SSC Engineering
Attention: Submittals
18207 Edison Ave.
Chesterfield, MO 63005.
 - 4. Emails regarding submittals shall be sent to "submittals@sscengineering.com".
- D. Documents transmitted in paper format shall be sent to the Architect who will forward these to SSC. If approved by the Architect prior to submitting documents, these documents may be submitted simultaneously to the Architect and SSC. SSC will return all documents to the Architect only regardless of how they were transmitted to SSC. Submit four (4) paper copies of all required Shop Drawings and material and equipment lists for the Engineer's and Owner's sole use. The Contractor shall submit additional paper copies that will be required for his own use and the Operation and Maintenance Manuals. The additional copies will be reviewed by the Engineer and returned to the Contractor marked accordingly.
- E. Documents transmitted as email attachments shall be sent simultaneously to the Architect and SSC. SSC will return one (1) electronic copy of these documents to the Architect only.
- F. Documents transmitted via FTP file transfers shall be retrieved from the FTP site after SSC has received an email notification that these documents have been posted to the site. SSC will return one (1) electronic copy of these documents to the Architect only unless another procedure is agreed to in writing by the Architect and the Engineer.
- G. Contractor shall review and correct all shop drawings before they are submitted. Shop drawings shall bear the signed and dated approval stamp of this Contractor.
- H. Shop drawings shall include the plan mark used on the plans.
- I. Equipment shop drawings shall give capacities at conditions specified and shall include manufacturer's catalog numbers and cuts. Shop drawings shall be clearly marked; shall indicate all accessories, items, conditions, etc., which are being furnished; and shall indicate that all conditions of the plans and specifications are being met. Wiring diagrams shall be submitted.

- J. Submittals which do not provide the required information will be returned unchecked.
- K. Contractor shall be responsible for deviations, errors and omissions, quantities, and coordination dimensions in submittals, and this responsibility shall not be relieved by Engineers' review of submittals.
- L. This Contractor shall coordinate each submittal with the contract documents, work of other contractors, and job site conditions.
- M. The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Engineer's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal and (1) the Engineer has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Engineer's approval thereof.
- N. This Contractor shall coordinate each submittal with the contract documents, work of other contractors, and job site conditions.
- O. Submit shop drawings on equipment as herein listed:
 - Panelboards
 - Safety switches
 - Motors and motor controls
 - Fuses
 - Lighting contactor
 - Conduit and boxes
 - Fire rated wall penetration sealer
 - Cable tray
 - Conductors
 - Wiring devices
 - Grounding equipment
 - Interior lighting
 - Exterior lighting
 - Fire alarm system
 - Lighting control system
 - Time switches
 - Surge protection devices
 - Occupancy sensors
 - Photo controls

1.8 RELEASE OF CADD FILES

- A. See "Release of Cadd Files Form" at the end of this section.

1.9 MAINTENANCE AND OPERATING INSTRUCTIONS AND MANUALS

- A. Upon completion of the job, the installing contractors and major suppliers shall instruct the Owner's representatives in the proper operation and maintenance of the systems installed. The installing Contractors shall submit documentation indicating the date of instruction; names and organization of persons providing and receiving the instructions; systems the instructions covered; and materials received.
- B. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

1. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 2. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
- C. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
- D. Contractor shall also submit four (4) complete hard copy sets and one (1) electronic copy of properly bound operating manuals to the Engineer for review. These manuals shall include the following:
1. Include a Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 2. Complete set of shop drawings.
 3. Copies of all submittals.
 4. Parts lists, wiring diagrams, piping diagrams, etc.
 5. Manufacturers' operating and maintenance instructions.
 6. Written operating and maintenance instructions for the system. This is a written version of Paragraph 1.9A above.
 7. Copies of warranties.
 8. Parts lists for each piece of equipment and name of local supplier.

1.10 TEMPORARY POWER – NEW FACILITIES

- A. The contractor's temporary electric service facilities shall include all required panels, switches, protective devices, conduit, wiring, receptacles, etc., required to extend service and adequately distribute light and power in accordance with NEC Article 590. Coordinate details of service and metering for job site and construction offices with local utility company. Energy charges shall be paid by the General Contractor.
- B. Temporary lighting shall consist of protected incandescent, LED, HID or fluorescent fixtures symmetrically spaced to produce a minimum of 5 footcandles throughout the work areas.
- C. Temporary power panels shall be located on each floor of multi-story buildings. Panel area served shall not exceed 25,000 square feet. Each panel shall power 12-20A, 120V, quadraplex GFI receptacles. Locate quadraplex receptacles on each floor to permit work in all areas with extension cord not exceeding 100 feet in length.
- D. Stairs and other enclosed areas shall have adequate lighting.
- E. The service shall be available during all working hours and scheduled overtime hours and otherwise as necessary for security and safety purposes, with security lighting to be provided during all hours of darkness. All such facilities shall conform to all requirements of the National Electrical Code, the local utility, and all other governmental authorities having jurisdiction.
- F. Temporary power shall be provided for all construction trailers.
- G. Comply with NECA 200-2010, "Recommended Practice for Installing and Maintaining Temporary Electric Power at Construction Sites."

1.11 AS-BUILT RECORD DRAWINGS

- A. During construction, maintain a separate set of drawings at the jobsite to keep a record of all changes of locations. See additional requirements in General Conditions and Supplementary Conditions.
- B. Locations of conduit and other concealed facilities shall be shown if and when they differ from the drawings. Underground conduit shall be dimensioned on those drawings.
- C. "As built" drawings are to be submitted to Architect/Engineer for review prior to the time of request for final payment. Submit as-built record drawings in accordance with the General Conditions.

1.12 GUARANTEE AND WARRANTY

- A. Guarantee and warrant equipment, materials, workmanship, installation, etc., for a period of one year in accordance with the General Conditions.
- B. During the guarantee period, make all required repairs and replacements, and provide necessary service, labor, tools, materials, parts, etc., at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIAL SUBSTITUTION

- A. Equipment selection has been based on one manufacturer to establish the desired type, style, quality, performance, etc. When other manufacturers are listed as equally acceptable, the product of those manufacturers will be accepted if their product complies with these specifications and drawings. The listing of a manufacturer does not relieve that manufacturer from complying with the specifications and drawings.
- B. Equipment and materials are subject to the review and approval of the Engineer and Architect.
- C. Differences in cost involved in using an equally acceptable manufacturer shall be included in the bid. Contractor shall be responsible for any and all engineering and installation variations due to the substituted equipment. These include structural, electrical, architectural, plumbing, mechanical, fire protection, etc. changes.
- D. Deviations from these specifications are not solicited and are not encouraged. If a deviation between the specifications or drawings and items bid does exist, then that deviation must be clearly itemized and explained on the bid form.

PART 3 - EXECUTION

3.1 RESPONSIBILITY

- A. Provide material, equipment, labor, services, supplies, etc., required to execute to completion work shown on the drawings, described in these specifications, or made necessary by the work shown on the drawings and/or described in these specifications.
- B. Schedule work and furnish the required materials in such a manner that the work may progress from start to finish in an expeditious and efficient manner without undue interruption. Schedule the work to coordinate with the construction.

3.2 COORDINATION OF TRADES

- A. Prior to the installation of any materials, review the drawings indicating work to be performed by each trade. If conflicts occur, they shall be brought to the attention of the Engineer for resolution.

- B. Work installed without coordinating with the other trades, which causes interferences, shall be removed and reworked, at no cost to the Owner.
- C. The Contractor supplying the equipment shall furnish all motors and components which are part of the equipment.
- D. Control wiring is defined as that wiring which conducts electrical energy at a voltage of less than 100 volts. Interlock wiring is defined as that wiring which performs a control function, but at a voltage of 100 volts or greater. All other wiring shall be considered power wiring.
- E. The Electrical Contractor shall furnish and install all power wiring to, and including connection to the equipment. Unless specifically noted otherwise, all interlock wiring shall be furnished and installed by the Electrical Contractor. Unless noted otherwise, the control wiring shall be furnished and installed by the Contractor furnishing the controlled equipment.
- F. Unless noted otherwise, the Electrical Contractor shall furnish and install all starters, disconnects, switches, push-button stations, etc., except those which are furnished with the equipment as a part of a factory-assembled package. Heater elements for overload relays on magnetic motor starters (except the starters factory pre-wired with equipment) shall be sized, furnished and installed by the Electrical Contractor. Magnetic motor starters for mechanical equipment (except starters factory pre-wired with equipment such as chillers and packaged air conditioners) shall be furnished by the Electrical Contractor. Magnetic motor starters will be provided with:
 1. Auxiliary contacts as required by the interlocks defined on the drawings or in the specifications.
 2. Control Power Transformer - 120 volt secondary, minimum 40 Volt Amps.
- G. Each Contractor furnishing motor-operated equipment shall furnish a list of motor characteristics to the Electrical Contractor so that properly sized heater elements may be provided. The list shall include equipment identification by name and by number, the full load current, locked rotor current, voltage rating, and suggested service factor to compensate for operating duty cycle and ambient temperatures.
- H. Unless specifically noted otherwise, pilot controllers (aquastats, flow switches, pressure switches, etc.) shall be furnished and mounted by the Contractor furnishing the controlled equipment.
- I. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls and other structural components as they are constructed.
- J. Coordinate sleeve selection and application with firestopping specified in Division 7.

3.3 PROTECTION OF EQUIPMENT AND WORK

- A. Protect and preserve materials, supplies, equipment, piping, etc., from damage due to weather, corrosion, dirt, vandalism, theft, etc. Provide enclosures or special protection as indicated by circumstances.
- B. Should any of the materials, equipment, etc., be damaged as a result of their negligence, then this Contractor shall be held responsible for all such damage and costs incurred for repair or replacement.

3.4 CONSTRUCTION STAGING

- A. Plan, coordinate and schedule the work to satisfy the project schedule.
- B. Work shall be so arranged that electrical power and other services are available to the building at all times, except for short periods of interruption necessary for the performance of new work.

Interruptions shall not be requested until the new services are complete and ready for final connection.

- C. Interruptions shall be scheduled, and services shall not be interrupted without written approval of the Owner's Representative. Notification to the Owner's Representative shall include the exact time and estimated duration of any interruption.

3.5 EQUIPMENT FURNISHED BY OTHERS

- A. Some pieces of equipment, as indicated on the drawings, will be furnished by the Owner's Vendor and/or under other Divisions of these specifications. Provide electrical work as shown for connections to this equipment. Refer to Specification Section 260024, "Separate Contracts", where applicable.
- B. Start-up of equipment furnished by the Owner or under other Divisions of these specifications shall be the responsibility of this Contractor under the Section assigned the responsibility to receive and set in place or to move and set in place.
- C. Warranties for equipment furnished shall be by the equipment manufacturer.

3.6 MAINTENANCE OF WORK AREAS

- A. This Contractor shall maintain the work area in an organized manner, shall not allow debris to accumulate, and shall store equipment, tools and supplies in a manner which shall not cause interference with the activities of others engaged on the project.
- B. Open ends of conduit, equipment and specialties shall be kept properly closed during construction and installation so as to avoid contamination.

3.7 CLEANING AND CLEANUP

- A. Upon completion of this work, clean all panels, fixtures, and equipment. Leave all work in a finished, clean, and satisfactory working condition.

END OF SECTION 260000

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SECTION 260010 – BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.
- B. Section 260000 - Basic Electrical Requirements.

1.2 SCOPE OF WORK

- A. This section supplements all sections of this Division and shall apply to all phases of work hereinafter specified, shown on the drawings, or required to provide a complete installation of electrical systems.

1.3 QUALITY ASSURANCE

- A. Electrical work including, but not limited to, installation, materials, equipment and wiring methods, shall comply with the applicable National Electrical Code, NFPA 70.
- B. Equipment and materials shall comply with the applicable requirements of the following:
 - 1. National Electrical Manufacturer Association (NEMA).
 - 2. Institute of Electrical and Electronic Engineers (IEEE).
 - 3. American National Standards Institute (ANSI).
 - 4. National Electrical Safety Code (ANSI Standard C2).
 - 5. Underwriters Laboratories (UL).
 - 6. National Electrical Contractors Association (NECA).
- C. Comply with NECA 1-2010, "Standard Practice of Good Workmanship in Electrical Contracting."

PART 2 - PRODUCTS

- 2.1 Provide products, components and materials which are listed and labeled by Underwriters Laboratories (UL). Test

2.2 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.
- B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- C. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

PART 3 - EXECUTION

- 3.1 Install equipment and materials in a neat and workmanlike manner and align, level, and adjust for satisfactory operation. Install equipment so that all parts are easily accessible for inspection, operation, maintenance and repair.
- 3.2 SUPPORTS
 - A. Provide the design, fabrication, and erection of supplementary structural framing required for attachment of hangers or other devices supporting electrical equipment.

- B. Provide members welded to structural members equal to the specification for the main structural member. Provide "simple beam" type framing with end connections welded or bolted for shear loads. Use cantilevers only when detailed or specifically approved by the Engineer. The Engineer's approval is required for location of supplementary framing.
- C. Design framing members for their actual loads, with allowable stresses specified by AISC, without excessive deflection and with consideration for rigidity under vibration, in accordance with standard structural practices.
- D. When supplementary framing is indicated, verify that dimensions are suitable for the equipment furnished. Provide additional strength when equipment furnished is heavier than that specified.

3.3 WIRING DEVICE LOCATION

- A. Position of Outlets: Center all outlets with regard to paneling, furring and trim. Symmetrically arrange outlets in the room. Satisfactorily correct outlets improperly located or installed. Repair or replace damaged finishes. Set outlets plumb and extend to the finished surface of the wall, ceiling, or floor without projecting beyond same. Install symmetrically all receptacles, switches, and outlets shown on the trim or casework. Where necessary set the long dimension of the plate horizontal, or ganged in tandem.
- B. Mounting heights, to center of box above finished floor, shall be as follows, unless otherwise indicated. Other mounting heights are indicated on the drawings by detail or by a plus dimension shown adjacent to the symbol:

Switches	46 inches
Receptacles and similar devices	18 inches
Receptacles in mechanical rooms	46 inches
Motor controllers and disconnect switches	60 inches to top
Panelboards	72 inches to top
Exterior WP convenience outlets	24 inches above grade
Telephone	18 inches
Wall telephone outlets	46 inches
Television outlets	18-90 inches
Push buttons	46 inches
Fire alarm manual station	46 inches
Fire alarm, Audio/Visual alarm device	Lower of 80 inches above floor or 6 inches below ceiling.

3.4 IDENTIFICATION

- A. General
 1. All electrical equipment and devices shall be identified by nameplates or labels.
 2. Nameplates - Shall be 4" x 1" x 1/8" thick white core, black face, plastic with engraved letters. Attachment to equipment shall be done by means of screws.
 - a. Nameplates shall be used for all major equipment such as switchboards, motor panelboards, motor control centers, transformers, panelboards (lighting, power and auxiliary) on each switch and starter in each panelboard and motor control center, disconnect switches, relays/contactors, loose mounted motor starters, and on control panels serving fire alarm, security and public address system and motor circuits.
 3. Labels (Stencils) - Shall be Brady or Westline and shall be color coded in accordance with ASA-Z34-1-53 "SAFETY COLOR CODE" to include system voltage, abbreviations of service, etc. For example: "480V", "Telephone", "Security", "Intercom", "Emergency", "120/208V", etc.

- a. In general, all exposed feeders, conduits, raceways, pull boxes, and junction boxes shall be identified.
 - b. For conduit systems installed for future wiring installations, all conduits and pull boxes, both exposed and above ceiling, shall be identified.
 - c. Labels shall be used on all bare or smooth painted surfaces. For rough textured surfaces, such as wrinkle painted surfaces or plastic materials where sticking labels would not be permanent, stencils or screwed on letters shall be used.
4. Label all low voltage wiring at both ends with Brady tags. Identify data and telephone cables by cable number and document on As-Built documents.

B. Equipment Identification

1. Panelboard - Nameplate shall designate panel number, upstream panel and voltage. Nameplate shall be mounted on the inside of panel door when the panel is located in finished areas and on the front of door when located in mechanical equipment rooms; typewritten branch circuit connection sheet shall be inserted within the panelboard manufacturer's' card holder.
2. Disconnect Switches and Motor Starters - Nameplates shall describe the equipment to be controlled and power circuit number.
3. Pushbutton Stations - Label shall identify the equipment controlled.
4. Transformers - Nameplate shall identify the equipment by plan designation, primary and secondary voltages, and KVA rating.
5. Auxiliary System Equipment - The control cabinets for auxiliary systems, such as fire alarm, P.A., intercom, program, etc., shall be identified with nameplate describing the system by designation, power circuit and voltage.
6. Fusible Switches - In addition to the nameplate, there shall be labeled on the inside of switch door, the fuse size required for equipment served.
7. Junction and Pull Boxes - Identify the function of the box such as "208 volt," "Telephone," "Fire Alarm," etc., with nameplates.

C. Raceway Identification

1. In general, all exposed feeder conduits, wireways, etc., shall be identified. Branch circuit designations shall be made only after the load balancing of the panelboards has been completed and shall be approved by Owner's representative. In general, designations shall include the area name and lighting type (e.g., Down Lights).
2. The identification labels shall be located at intervals of 50 feet or less and at every point where a conduit or raceway is entering and leaving a room.

D. Device Circuit Identification

1. Receptacles shall be identified by panel name and circuit number, with labels adhered to the device cover plate.

3.5 TEST

- A. Provide the tests as outlined hereinafter and other tests necessary to establish the adequacy, quality, safety, completed status and suitable operation of each system.
- B. Ground Rod Test: Immediately after installation, test driven grounds and counterpoises with a Ground Resistance Direct-Reading Single-Test Megger, utilizing the AC Fall-of-Potential Method and two reference electrodes five (5) feet deep. Disconnect the ground rod to be tested

from other ground systems at the time of testing. The ground resistance for the electrical service shall be 15 ohms or less. Submit the results, date of test, and soil conditions, to the Engineer in writing, immediately after testing.

- C. Balance phase currents of all distribution panels and branch circuit panels within plus or minus 10 percent variation between average phase current and measured individual phase currents.
- D. Written test record shall be supplied to the Owner to show compliance with governing codes for grounding continuity.
- E. Final Corrections: Correct promptly any failure or defects revealed by these tests as determined by the Engineer. Reconduct tests on these corrected items as directed by the Engineer.

3.6 CONCRETE WORK

- A. Provide concrete work for electrical equipment as follows:
 - 1. Nominal 4" concrete pads for switchboards, dry-type transformers, motor control centers, VFDs, ATSES and floor mounted panelboards. Concrete bases shall extend 1" beyond the equipment footprint unless specified otherwise.
 - 2. Concrete base for free-standing exterior lighting equipment, including parking lot light poles, walk lighting, flood lights and other work as indicated on the drawings.
 - 3. Provide concrete pad for utility transformer in accordance with utility requirements.
 - 4. Concrete work shall comply with the requirements of Division 3. Minimum concrete strength at 28 days shall be 3000 psi. Provide reinforcing steel per ACI standards.

3.7 CUTTING AND PATCHING

- A. Provide openings for conduit, by means of sleeves.
- B. Provide cutting required for conduits if sleeves or openings are not properly provided. Under no circumstances shall any structural members, load bearing walls or footings be cut without first obtaining written permission from the Structural Engineer.
- C. Cutting shall be limited to the size necessary for working conditions. When cutting surfaces are difficult or costly to replace, such as marble, glazed tile, wood paneling, etc., obtain the Owner's approval in advance of the cutting and patching.
- D. Before cutting or drilling holes in floors, verify the location of reinforcing steel bars and embedded electrical conduits to avoid cutting same. X-ray floors where necessary to verify such locations. Contact the Engineer before proceeding with cutting if such obstructions interfere with the locations of planned holes.

3.8 ROOF OPENINGS

- A. Provide cutting, patching and flashing of roof for conduits through roof. Roof cutting and patching shall be coordinated with the roof installer. The original roof warranty shall be maintained.

3.9 PAINTING

- A. Electrical equipment shall be factory finished standard color as furnished by the manufacturer. Scratches shall be touched up in the field after equipment is installed with paint which matches the original color.

3.10 EXCAVATION

- A. Excavate, as necessary, for underground conduit, etc.

- B. Material to be excavated shall be non-classified and shall include all earth or other materials encountered.
- C. Unless otherwise shown, provide separate trenches for each utility. Install all conduit in open trench.
- D. Excavation of trenches from surface to top of conduit shall be kept to a minimum but shall be of sufficient width for proper installation of the work. Provide ample excavation under and around all conduit joints to permit proper installation of connectors.
- E. Excavations shall be properly protected by the necessary bracing and timbers to prevent any cave-ins or injury to adjacent improvements and workmen. The sides of all trenches shall be securely held by bracing or sheeting, which shall not be removed until the level of the backfill has reached the point where such removal can be safely carried out. The thickness of the sheeting and the dimensions of the cross-braces, shoes, etc., shall be satisfactory to protect properly the sides of the trench and to prevent injurious cave-ins or erosions.
- F. Grading in the area of the excavation will be such that it shall prevent surface water from flowing into the excavated trench. Do not install conduit in water.
- G. Where underground conduits cross, the trench of the lower conduit shall be backfilled with sharp sand, well tamped, to provide bed for higher conduit. Lines which run parallel and at different levels shall be adequately separated to provide firm bedding for the conduits.

3.11 BACKFILLING

- A. Excavations shall be promptly backfilled.
- B. Trenches for conduit, etc., shall be backfilled for a depth of at least one (1) foot over the top of conduit with minus. It shall be carefully deposited in uniform layers not exceeding six (6) inches in depth. Each layer shall be carefully and solidly tamped with appropriate tools in such a manner as to avoid injuring or disturbing the completed work. Backfill shall be placed thoroughly compacted to prevent lateral displacement.
- C. Backfill from 1'-0" above the top of the conduit to 6" below grade shall be clean on-site materials. Rocks or other materials over 3/4" shall be removed. The last 6" of backfill shall be topsoil in planted areas, or earth in non-planted areas, or other materials as required by the architect, civil or site engineer when passing below asphalted or concrete areas. Place earth material in 6" to 8" maximum thickness layers and compact to dry density of at least 95% of maximum dry density as measured by Modified Proctor.
- D. Backfill from 1'-0" above the top of the conduit to the bottom side of sidewalks, parking areas, streets, floor slabs or other paved areas shall be with crushed stone or gravel with maximum size of 1/2".
- E. Do not place fill during rainy or freezing weather or on subgrade softened by rain or thawing action. When filling is interrupted by weather, top surface of fill shall be scarified, re-compacted, and tested before placing new fill. Each day's fill shall be constructed with a slope that will ensure free and rapid drainage.
- F. If the soils are too wet during construction of the fill, air dry or scarify and re-compact.
- G. The Owner shall have the option of requiring compaction tests. If the material tested does not meet these tests, this Contractor shall bear the cost of retesting and remedial work.

END OF SECTION 260010

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SECTION 260024 – SEPARATE CONTRACTS

PART 1 - GENERAL

- 1.1 The Owner shall issue separate contracts for purchase, furnishing and installation of specialty systems and miscellaneous items listed in Part 2.
- 1.2 The EC shall be required to install, connect and wire Owner furnished equipment in some cases. In all cases, power connections, rough-in conduit and boxes are minimum requirements.
- 1.3 RELATED DOCUMENTS
 - A. All drawings and applicable provisions of Division 0 Bidding Requirements and Division 1 General Requirements apply to work of this Section.
 - B. Section 260000 – Basic Electrical Requirements.
 - C. Section 260010 – Basic Electrical Materials and Methods.

PART 2 - PRODUCTS

- 2.1 Owner shall issue separate contracts for the following systems:
 - A. Video Surveillance System
 - B. Telephone/Data System Equipment
 - C. Security/Access Control System
 - D. Television and Audio/Visual System
- 2.2 EC shall furnish and install power, conduit, wire, pull wire, boxes, outlets, etc., as called for on drawings for the above systems. Coordinate with owner's vendor(s) for electrical requirements.

PART 3 - EXECUTION

- 3.1 The EC shall include all costs for rough-in conduit systems.

END OF SECTION 260024

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SECTION 260055 – ARC FLASH HAZARD ANALYSIS / SHORT-CIRCUIT / COORDINATION STUDY

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by A Licensed Professional Electrical Engineer as detailed in Qualifications paragraph below.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the current version of NFPA 70E -Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584 - 2002, the IEEE Guide for Performing Arc-Flash Calculations.
- C. The scope of the studies shall include new distribution equipment installed by Electrical Contractor under this contract.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract.

1.3 REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. IEEE 141 - Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
 - 2. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 - 3. IEEE 399 - Recommended Practice for Industrial and Commercial Power System Analysis
 - 4. IEEE 241 - Recommended Practice for Electric Power Systems in Commercial Buildings
 - 5. IEEE 1015 - Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
 - 6. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations
- B. American National Standards Institute (ANSI):
 - 1. ANSI C57.12.00 - Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
 - 2. ANSI C37.13 - Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
 - 3. ANSI C37.010 - Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
 - 4. ANSI C 37.41 - Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.
- C. The National Fire Protection Association (NFPA)
 - 1. NFPA 70 -National Electrical Code, latest edition
 - 2. NFPA 70E - Standard for Electrical Safety in the Workplace

1.4 SUBMITTALS FOR REVIEW / APPROVAL

- A. The studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the study may cause delays in equipment shipments, approval from the Engineer may be obtained for a preliminary submittal of data to ensure that the selection of device ratings and characteristics will be satisfactory to properly select the distribution equipment. The formal study will be provided to verify preliminary findings.

1.5 SUBMITTALS FOR CONSTRUCTION

- A. The results of the short-circuit; protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. A minimum of five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report shall be provided without the section containing the computer printout of the short-circuit input and output data. Electronic PDF copies of the report shall be provided upon request.
- B. The report shall include the following sections:
 - 1. Executive Summary including Introduction, Scope of Work and Results/Recommendations.
 - 2. Short-Circuit Methodology Analysis Results and Recommendations
 - 3. Short-Circuit Device Evaluation Table
 - 4. Protective Device Coordination Methodology Analysis Results and Recommendations
 - 5. Protective Device Settings Table
 - 6. Time-Current Coordination Graphs and Recommendations
 - 7. Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.
 - 8. Arc Flash Labeling section showing types of labels to be provided. Section will contain descriptive information as well as typical label images.
 - 9. One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.

1.6 QUALIFICATIONS

- A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.
- B. The Registered Professional Electrical Engineer shall be an employee of the equipment manufacturer or an approved engineering firm.
- C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.
- D. The calculations shall be signed and sealed by a registered professional engineer of the state in which the project occurs.

1.7 COMPUTER ANALYSIS SOFTWARE

- A. The studies shall be performed using SKM Systems Analysis Power*Tools for Windows (PTW) software program or equivalent from ETAP.

PART 2 - PRODUCT

2.1 STUDIES

- A. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E -Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D. This study shall also include short-circuit and protective device coordination studies. All studies to be prepared by the Licensed Professional Electrical Engineer.

2.2 DATA

- A. Contractor shall furnish all data as required for the power system studies. The Engineer performing the short-circuit; protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
- B. Source combination may include present and future motors and generators.
- C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.
- D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT ANALYSIS

- A. Transformer design impedances shall be used when test impedances are not available.
- B. Provide the following:
 1. Calculation methods and assumptions
 2. Selected base per unit quantities
 3. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis
 4. The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
 5. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.
 6. Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.
- C. For solidly-grounded systems, provide a bolted line-to-ground fault current study for applicable buses as determined by the engineer performing the study.
- D. Protective Device Evaluation:
 1. Evaluate equipment and protective devices and compare to short circuit ratings
 2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
 3. The electrical contractor shall notify the Engineer in writing, of any circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE TIME-CURRENT COORDINATION ANALYSIS

- A. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.
- B. Include on each TCC graph, a complete title with descriptive device names.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

- D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the TCC graphs, where applicable:
 - 1. Electric utility's overcurrent protective device
 - 2. Medium voltage equipment overcurrent relays
 - 3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
 - 4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
 - 5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
 - 6. Medium voltage conductor damage curves
 - 7. Ground fault protective devices, as applicable
 - 8. Pertinent motor starting characteristics and motor damage points, where applicable
 - 9. Pertinent generator short-circuit decrement curve and generator damage point
 - 10. The largest feeder circuit breaker in each motor control center and applicable panelboard.
- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.
- G. Provide the following:
 - 1. A One-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
 - 2. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
 - 3. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
 - 4. The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the device is located, and the device number corresponding to the device on the system one-line diagram
 - 5. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.
 - 6. The contractor shall notify the Engineer in writing of any significant deficiencies in protection and/or coordination. Provide recommendations for improvements.

2.5 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2009, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis (Section 2.3) and the protective device time-current coordination analysis (Section 2.4)

- B. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- C. Circuits 240V or less fed by single transformer rated less than 125 kVA may be omitted from the computer model.
- D. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.
- E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations
- F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.
- G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond 5 cycles.
- H. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.
- I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
- J. Miscoordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.
- L. Provide the following:
 - 1. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection

- boundary distances, working distances, personal-protective equipment classes and AFIE (Arc Flash Incident Energy) levels.
2. The Arc-Flash Hazard Analysis shall report incident energy values based on recommended device settings for equipment within the scope of the study.
 3. The Arc-Flash Hazard Analysis may include recommendations to reduce AFIE levels and enhance worker safety.

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

- A. Contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the Electrical Contractor.
- B. Contractor shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. The Contractor shall notify the Engineer in writing of any required major equipment modifications.

3.2 ARC FLASH LABELS

- A. The Contractor shall provide a 4.0 in. x 4.0 in. Brady thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. The labels shall be designed according to the following standards:
 1. UL969 - Standard for Marking and Labeling Systems
 2. ANSI Z535.4 - Product Safety Signs and Labels
 3. NFPA 70 (National Electric Code) - Article 110.16
- C. The label shall include the following information:
 1. System Voltage
 2. Flash protection boundary
 3. Personal Protective Equipment category
 4. Arc Flash Incident energy value (cal/cm²)
 5. Limited, restricted, and prohibited Approach Boundaries
 6. Study report number and issue date
- D. Labels shall be printed by a thermal transfer type printer, with no field markings.
- E. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:
 1. Floor Standing Equipment - Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.
 2. Wall Mounted Equipment - Labels shall be provided on the front cover or a nearby adjacent surface, depending upon equipment configuration.
 3. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.

- F. Labels shall be field installed by the Contractor. The technician providing the installation shall have completed an 8-Hour instructor led Electrical Safety Training Course which includes NFPA 70E material including the selection of personal protective equipment.

3.3 ARC FLASH TRAINING

- A. The vendor supplying the Arc Flash Hazard Analysis shall train the owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). The trainer shall be an authorized OSHA Outreach instructor.
- B. The vendor supplying the Arc Flash Hazard Analysis shall offer instructor led and online NFPA 70E training classes.

END OF SECTION 260055

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SECTION 260060 – ELECTRICAL SERVICE

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers the electrical service from local utility.
- B. Service shall be as follows:
 - 1. Pad mount transformer.

1.2 RELATED SECTIONS

- A. Refer to other sections for conductors, switchboards, and raceways, fittings and boxes.

1.3 UTILITY SERVICE

- A. Verify all details relative to the Utility Company's installation and termination requirements. Furnish and install all such material required by the Utility Company.
- B. The building service voltage shall be 120/208 volts, 3 phase, 4 wire.
- C. The Utility is Ameren.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 PAD MOUNTED TRANSFORMER SERVICE

- A. Electrical contractor shall
 - 1. Furnish and install underground primary conduit from the transformer pad to a location at the property line that is determined by the Utility. The conduit shall be 4" schedule 40 PVC at a minimum depth of three (3) feet and shall contain a pull tape.
 - 2. Obtain the transformer pad from the Utility, transport it to the site, and set it in place. At the contractor's option, they may pour a pad (at the site) which conforms to the Utility specifications.
 - 3. Furnish and install the secondary feeders from the pad-mount transformer to the service entrance switchboard.
 - 4. Furnish and install the CT/PT enclosure, meter enclosure and conduit from the current transformers to the meter enclosure, as required by the utility. Install the Utility-furnished current transformers, metering wire harness, and potential transformers.
 - 5. Furnish and install meter ground (including conductors, rods and connections).
- B. The utility shall
 - 1. Furnish and install the primary cables in the contractor-provided underground primary conduit.
 - 2. Furnish and install the pad-mounted transformer.
 - 3. Make all terminations inside the transformer.
 - 4. Furnish the current transformers, metering wire harness, and potential transformers to the Electrical Contractor.
 - 5. Furnish and install the meter.

END OF SECTION 260060

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SECTION 260070 – ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers electrical connections to equipment.

1.2 EQUIPMENT CONNECTIONS

- A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.
- B. Refer to drawings for additional requirements.
- C. Applications of electrical power connections specified in this section include the following:
 - 1. From electrical source to motor starters/VFDs.
 - 2. From motor starters/VFDs to motors.
 - 3. From electrical source to equipment with pre-wired control panels.
- D. Provide electrical connections for equipment, specified in Division 21, 22, & 23 and in other Division 26 sections.
- E. Provide motor starters and controllers, not furnished as part of equipment.
- F. Refer to Motor and Equipment Schedule on drawings and Division 21, 22, & 23 sections for motor starters and controllers furnished with equipment.
- G. Provide disconnect switches and junction boxes required for connecting motors and other electrical units of equipment.
- H. Provide electrical identification for wire/cable conductors.
- I. Provide raceways and wires/cables required for connecting motors and other electrical units of equipment.
- J. Temperature control system wiring will be provided under Division 23.
- K. Provide electrical work for elevators as described herein, and as indicated on the drawings.
- L. Provide electrical work for kitchen equipment as described herein, and as indicated on the drawings.
- M. Refer to sections of other divisions for specific individual equipment power requirements requiring electrical connections.

1.3 QUALITY ASSURANCE

- A. ANSI Compliance: Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.
- B. U.L. Compliance: Comply with U.L. Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials which are U.L. listed and labeled.
- C. Comply with NFPA 70 "National Electrical Code" for components and installation.

PART 2 - PRODUCTS

2.1 Provide products, components and materials which are listed and labeled by UL.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF ELECTRICAL CONNECTIONS

- A. Install electrical connections as indicated, in accordance with equipment manufacturer's written instructions and with recognized industry practices and complying with applicable requirements of U.L., NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.
- B. Coordinate with other work, including wire/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
- C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- D. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating than, the electrical insulation rating of those conductors being spliced.
- E. Prepare cables and wires by cutting and stripping covering armor, jacket and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.
- F. Trim cables and wires as short as practicable and neatly arrange routing to facilitate inspections, testing and maintenance.
- G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torqueing tools, including torque screwdriver, beam-type torque wrench and ratchet wrench with adjustable torque settings. Where manufacturer's torqueing requirements are not available, tighten connectors and terminals to comply with torqueing values contained in U.L.'s 486A.
- H. Provide flexible conduit for motor connections and other electrical equipment connections, where subject to movement and vibration.
- I. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subjected to one or more of the following conditions:
 - 1. Exterior location
 - 2. Moist or humid atmosphere where condensate can be expected to accumulate
 - 3. Corrosive atmosphere
 - 4. Water spray
 - 5. Dripping oil, grease or water
 - 6. Kitchens or Dishwash areas
- J. Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number in accordance with Division 26, Sections

260010 and 260120, Part 3.4. Affix markers on each terminal conductor, as close as possible to the point of connection.

3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION 260070

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SECTION 260110 – RACEWAYS, FITTINGS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

- A. This section includes raceways, fittings and outlet boxes.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70 "National Electrical Code" for components and installation.
- B. Comply with NECA 101, "Standard for Installing Steel Conduit (Rigid, IMC, EMT)."
- C. Comply with NECA 111, "Standard for Installing Non Metallic Raceways (RNC, ENT and LFNC)."
- D. Comply with NECA 120, "Standard for Installing Armored Cable (Type AC) and Metal Clad Cable (Type MC)."
- E. Comply with NECA 605, "Recommended Practice for Installing Underground Nonmetallic Utility Duct."

PART 2 - PRODUCTS

2.1 RACEWAYS (Raceways shall be new and shall bear the UL label)

- A. Electrical Metallic Tubing: Shall be cold rolled welded steel conduit, galvanized on both the outside and inside. Connectors and couplings shall be steel alloy. Setscrew connectors and couplings are approved for indoor exposed or concealed (but not encased in concrete or masonry) work only. Gland compression connectors and couplings are approved for all locations. Indenter type connectors and couplings are not approved. Connectors up to and including size 1-1/2" shall be with insulated throat. Connectors shall be terminated with a bonding type locknut and for conduit sizes 2" and larger, a plastic insulated bushing. Threaded steel insulated grounding bushings having solderless lugs shall be used where required. Comply with ANSI C80.3. Connectors shall be steel; die-cast is not acceptable.
- B. Intermediate Metal Conduit (IMC): Shall be zinc-coated steel tubing. Comply with ANSI C80.6.
- C. Rigid Steel Conduit: Shall be zinc-coated rigid steel conduit and conduit fittings. Comply with ANSI C80.1 and UL 6. Couplings and fittings shall be of the threaded type. Threadless fittings shall be used only when specific approval is given by the engineer.
- D. Flexible Metallic Conduit: Shall be zinc-coated steel, single strip type, UL listed. Use Anaconda "Sealtite" flexible, liquid-tight conduit in damp or wet locations.
- E. Surface Metal Raceways: Shall be a two-piece steel raceway with removable covers, sizes indicated on the drawings, complete with fittings and all components necessary for a complete installation.
- F. Rigid PVC Conduit: Shall be heavy wall polyvinyl chloride conduit, Type 40 (NEMA EPC-40-PVC, Type II/III). Comply with NEMA TC-2.
- G. Wireway: Shall be constructed of code gauge steel and shall be in accordance with Underwriters Laboratories Standard UL-870 for Wireways, Auxiliary Gutters and Associated

Fittings. Wireway shall be lay-in type (no cross bars or straps) with hinged cover. Indoor wireway shall be constructed with knockouts. Outdoor wireway shall be raintight with no knockouts. Sheet metal parts shall be coated with a rust-inhibiting primer and a gray baked enamel finish. Hardware shall be plated to prevent corrosion. Wireway shall be of standard dimensions and sized in accordance with the National Electrical Code for the particular installation. Wireway shall be Square D "SQUARE-DUCT" or approved equivalent.

2.2 OUTLET BOXES

- A. Provide outlet boxes; pull boxes, and conduit fittings as described below. Catalog numbers shown are those of Appleton Electric Company, Steel City, National Electric Products Corp., and Raco are equally acceptable. Comply with NEMA OS-1 and FB
1. Lighting Boxes (concealed) - No. 40-3/4
 2. Lighting Boxes (concrete) - No. OCR Series
 3. Lighting Boxes (exposed) - No. 4S-3/4 or 40-3/4
 4. Switch, Receptacle, Telephone and Junction Boxes (flush) - No. 4S-3/4 or No. 225 where separate extension or plaster ring cannot be used.
 5. Switch, Receptacle, Telephone and Junction Boxes (exposed) - FS Series
 6. Switch and Telephone Boxes (concealed in narrow mullions) - Bell Electric Co. No. 447, 448, or 449.
 7. Weatherproof or Exterior Boxes - FS Series with weatherproof while-in-use cast metal cover and neoprene gasket.
- B. Where space is limited, No. 4CS-3/4 handy boxes may be used for a switch, receptacle, telephone or other outlet.
- C. Provide extension and plaster rings as required.
- D. Size outlet boxes in accordance with the allowable fill permitted by the National Electrical Code.

2.3 PULLBOXES

- A. Provide code gauge galvanized sheet metal pull boxes sized as per the National Electrical Code or as shown on the drawings. Provide a removable cover on the largest access side of the box unless otherwise detailed. Where cast boxes are specified, provide conduit entrances with threaded hubs. Provide stainless steel screws in all exterior locations and in wet or damp locations.

2.4 CONDUIT FITTINGS

- A. UL-514B, NEMA FB-1 and NEMA TC-3 listed. Steel material, die-cast is not acceptable.
- B. EMT Couplings:
1. Series 95T gland compression (all locations).
 2. Series TWC set screw (indoor only but not encased in concrete or masonry)
 3. Steel material, die-cast is not acceptable.
- C. EMT Connectors:
1. Series 86T gland compression (all locations)
 2. Series TW set screw (indoor only - but not encased in concrete or masonry)
 3. Steel material, die-cast is not acceptable.
- D. Insulating Bushings (1-1/4 inch rigid conduit and larger) - Series BBU
- E. Straight Box Connectors (flexible conduit) - Series 728 9V
- F. Angle Box Connectors (flexible conduit) - Series 738 2V

- G. Sealing Gland Assembly - OZ, Type FSK
- H. Expansion Joints - OZ, Type AX or TX with bonding jumpers and clamps.
- I. Expansion and Deflection Fittings - OZ, Type DX
- J. Cast Metal Conduit Fittings - Crouse-Hinds, Condulets form 7 with wedge nut cover.

2.5 PREFABRICATED CONDUIT STANDS ON ROOF

- A. Shop fabricated assemblies made of corrosion-resistant components to support roof mounted conduit and compatible with roof surfaces.
- B. Caddy Pyramid fixed and adjustable strut supports of length, load rating and height to match requirements.

PART 3 - EXECUTION

3.1 RACEWAYS - GENERAL

- A. Install all wiring, including telephone, low voltage, etc., in raceways as indicated on the plans and in this specification.
- B. Install raceways concealed, except in mechanical equipment rooms or where indicated on the plans.
- C. Minimum raceway size shall be ½" for interior applications and 1" for exterior applications.

3.2 APPLICATION

- A. Conduits located exposed, concealed inside shafts or column enclosure and all homeruns shall be EMT. PVC shall be used in concrete slabs, but last elbow out of floor slab shall be IMC. Minimum 2" concrete above conduit.
- B. Conduits run horizontally between boxes containing wiring devices in walls shall be either EMT or metallic flexible conduit. The maximum length of metallic flexible conduit between wiring devices in furred walls shall be twelve (12) feet. All other horizontal conduit in furred walls shall be EMT.
- C. Exterior conduits exposed above grade shall be galvanized rigid steel, 1" minimum.
- D. Sleeves and conduits for feeders over 600 volts shall be rigid steel conduit.
- E. Conduits for connection to vibrating equipment such as motors, transformers, etc., and for heat loops to light fixtures from junction boxes above them shall be metallic flexible conduit, maximum length of six feet. Weatherproof Sealtite shall be used in damp or wet locations.
- F. Conduits located below grade in direct contact with the earth shall be schedule 40 PVC conduit. These raceways shall be encased in 3 inches of concrete where indicated. Refer also to 260115, Underground Ducts.
- G. Provide cable tray, Wiremold, Plugmold, wireways, and other special raceways where indicated on the drawings. Wiremold shall be used for all circuits which will be exposed in finished spaces.
- H. Any type of conduit or raceway that is specifically labeled on the plans shall take precedence over the specification. Obtain written permission from the Engineer for any other deviation from the specification requirements.

- I. Keep emergency and normal raceways separate and follow separate routes. Normal and emergency conductors shall not be installed in the same raceway.

3.3 INSTALLATION

- A. Continuity. Provide metallic raceways continuous from outlet to outlet, and from outlets to cabinets, junction or pull boxes. Enter and secure conduit to all boxes to provide electrical continuity from the point of service to outlets. Provide double locknut and bushing on terminations of metallic conduits.
- B. Raceways Exposed. Run exposed raceways in straight lines at right angles or parallel with walls, beams or columns.
- C. Raceways in Concrete:
 - 1. Do not place raceways in plain concrete, such as cement toppings on structural floors, without special approval of the Architect.
 - 2. Do not displace reinforcing steel to accommodate the installation. In general, locate all embedded conduits in the physical center of the particular section of concrete. Provide raceways embedded in reinforced concrete conforming to the following usual types of conditions.
 - 3. Floors and Walls - Maximum Allowance: displacement of 1/3 of thickness of concrete spaced not less than three diameters on centers.
 - 4. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- D. Sleeves: Sleeves through floors and walls shall be not less than three diameters on centers. Conduit sleeves in floors shall be steel and shall extend 3 inches above the finished floor and flush with the underside of the floor slab. Size sleeves to provide ¼" annular clear space (interior sleeves) or 1" (exterior sleeves) between sleeve and raceway.
- E. Sealing of Sleeves: Openings and sleeves through which a conduit passes in non-fire rated walls, floors, and ceilings shall be properly sealed after the conduit is installed to prevent transmission or leakage of liquids, smoke, and sound. Conduit passing through drywall construction or sleeves shall be sealed both sides of the opening shall be caulked with a resilient non-hardening caulking such as U.S.G. Acoustical Sealant, Tremco, or approved equal.
- F. Sealing of Sleeves: Conduit passing through fire rated floors, walls and ceilings shall be sealed by a UL Listed System with hourly rating equivalent to fire rated floors, walls or ceilings. Fire proofing materials by S.T.I., U.S.G., Tremco, 3M and Hilti must be installed according to UL Listed Systems.
- G. Sleeves for fire rated walls and ceilings where data, voice, etc., cables penetrate fire walls or fire rated ceilings provide a fire stopping system as manufactured by STI EZ-Path, Wiremold FlameStopper or equal. Fire stopping system shall be UL classified and FM approved in accordance with ASTM E814 (UL1479).
- H. Raceways through Exposed Roof: Where raceways penetrate the roof seal, provide suitable pitch pockets of lead flashing or flexible boot-type flashing units applied in coordination with roofing work.
- I. Raceways Entering the Building Below Grade (or raceways through a roof covered by earth): Provide raceways with stainless steel plates and hardware with EDPM or NBR links and wall entrance mechanical sleeve seals having a water tight sealing gland assembly where the raceways enter into a dry area. Use OZ Gedney type FSK or equivalent seal. Following installation of conductors, cables and pull tapes in raceways, provide water stop inside conduits equivalent to Tyco RDSS and RDSS-Clip inflatable sealing bladders.

- J. Bends. Where more than one conduit in a bank of exposed conduit changes direction, all bends shall be concentric. Conduit bends shall not be less than standard radius. Conduit bends for power feeders over 600 volts and for telephone feeders shall be long radius.
- K. Threads. Clean all threads of rigid conduit. Coat all male threads of all steel conduit installed underground or in or under concrete slabs with teflon immediately before being coupled together.
- L. Running Threads. Use "Erickson" type couplings in lieu of running threads.
- M. Protection. Cap raceways stubbed up, including those in cabinets, immediately upon their installation. The use of paper or rag wads will not be permitted.
- N. Expansion Joints. Provide raceways crossing expansion joints with Type BJ bonding jumper for bonding conduit or tubing together. Where differential settlement may occur, use deflection fittings.
- O. General Location Requirements. Raceway runs shown are diagrammatic. Determine exact locations in the field except where otherwise noted or where dimensions are specified on the drawings. Conduits shall not run within 12 inches of pipes carrying hot liquids, steam, or gases.
- P. Pull Tapes. Empty conduits shall be provided with a pull tape.
- Q. Provide accessories as required for a complete installation, including insulated bushings and inserts where required by the manufacturer or NEC. Provide insulated bushings on all conduit stub-ups, where conduit does not terminate in a box or enclosure, and on all enclosure openings where cables enter or exit unprotected by conduit.
- R. Install no more than the equivalent of three 90-degree bends in any conduit run except for communication conduits. Communications conduits shall have a maximum of two 90-degree equivalent bends for each raceway. Communication conduits 3/4" and less shall be installed in maximum lengths of 50 feet and 1" and larger at 75 feet maximum lengths.

3.4 RACEWAYS SUPPORTS

- A. Supports. Install raceway supports in accordance with the requirements of the National Electrical Code. Do not anchor or strap conduits to the ceiling furring channels or attach to ceiling hanger wires.
- B. Straps and Hangers. Conduit shall be supported from building structure on approved types of galvanized brackets, ceiling trapeze or pipe straps, or hangers secured by means of toggle bolts on hollow masonry; or expansion bolts in concrete or brick; or machine screws on metal surfaces; or wood screws on wood construction. Conduits shall be attached to the hanging systems by fittings equal to those manufactured by Caddy Fasteners. Nails shall not be used as a means of fastening boxes or conduits. Perforated flat steel straps shall not be used for supporting conduit. Conduits shall not be supported from ductwork or ductwork supports. Conduit shall be properly supported in order to deter any possible vibration, noise, or chatter.

3.5 PREFABRICATED CONDUIT STANDS

- A. Conduit Stands: In general, provide a low type support. Where the elevation of the roof changes or where the conduit is required to slope, provide an adjustable type support that can accommodate the different support heights needed to maintain the proper conduit elevation above the roof.
- B. Conduit support schedule:

Conduit Type	Erico Caddy Basis of Design		Support Spacing
	Model	Max Height	

EMT/IMC/RIGID	F: PSF6C	F: 4.8 inches	60 inches
EMT/IMC/RIGID	A: PSA10CH13	A: 13 inches	96 inches
EMT/IMC/RIGID	A: PSA16AH18	A: 18 inches	96 inches
Notes:			
<ol style="list-style-type: none"> 1. Conduit support spacings are maximums. Adjust so maximum base load does not exceed 2.5 psi, or deflection of conduit or piping exceeds 1/240 of span between supports. 2. Locate supports within 12 inches of each conduit joint. 3. Locate supports within 24 inches of each change in direction of conduit. 4. Use adjustable-type units where fall of roof differs from required fall of item supported. 5. Do not use wood blocking to produce fall in supported items. Do not shim or install wedges under conduit supports. 6. For use and conditions other than those listed, select from conduit supports specified, or if not otherwise indicated for application, from manufacturer's product selections suited and applicable for use and conditions. 7. F: Fixed-Height Units; A: Adjustable Height Units. 8. Provide conduit strap(s) to hold conduit(s) to unit. 			

- C. Preparation: Clean roof primary or secondary membrane surfaces at each conduit support base. Remove loose dirt, dust, oils, and other foreign materials from all roofs.
1. For membrane roofing systems, refer to Division 07 Sections for requirements for preparations for setting of conduit support bases.
- D. Installation: Support all electrical, control, data, or other conduits, and other horizontal conduits for their entire length.
1. Assemble frames, bases, hangers, clamps, rollers, clevises, and hardware per manufacturer's instructions using corrosion-resistant or stainless steel fasteners and clamps.
 2. Anchor or clamp conduits to conduit supports unless otherwise indicated.
 3. Adjust supports to place supported items at proper elevation, true to line, without abrupt changes of plane or direction, with conduits fully seated on supports strapping.
 4. Install Conduit supports to allow for anticipated expansion and contraction of conduits without movement of bases.
 5. Install roller type supports at each side of roof expansion assemblies.
 6. Do not exceed maximum loads on each support per conduit support manufacturer.
 7. Space conduit supports closer together where required to comply with maximum weight limitations on each support assembly.
- E. Setting: Set conduit support bases in accordance with roofing and conduit support manufacturer's installation instructions. Accurately locate and align bases.
1. Install conduit supports with base assemblies centered in secondary roofing membrane applied atop primary roof membrane surfaces.
 2. Coordinate installation of membrane straps with base conditions and configuration.
 3. Refer to Division 07 Sections for roofing requirements for conduit support bases.

3.6 JOINTS AND CONNECTIONS

- A. Metal Conduits. Make watertight all couplings and threaded connections in threaded conduit. Cut all joints square, ream smooth, and properly thread. Fit all box connections with a minimum of two approved locknuts and one steel, plastic or fiber bushing forming an approved tight bond with box. Provide locknuts both inside and outside of the enclosure to which the conduit is attached. Use rain tight compression type fittings for electrical metallic tubing systems and use at least one locknut on the inside of each enclosure entry. Provide grounding locknuts or bushings where required in Section 260455 GROUNDING SYSTEMS.

- B. PVC Conduits. Make watertight all couplings and connectors in conduit runs. Utilize solvent cement joints of a type approved by the manufacturer for all couplings and fittings. Provide adapters and locknuts where conduit is attached to metal junction boxes, panels, etc.
- C. Join raceways with fittings designed and approved for the purpose and make joints tight. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight. Use insulating bushings to protect conductors.
- D. Tighten set screws of threadless fittings with suitable tool.
- E. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box.
- F. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
- G. Flexible Connections: Use maximum of 6 feet (1830 mm) of flexible conduit for recessed and semi-recessed lighting fixture; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor in flexible connections.

3.7 BOX APPLICATIONS

- A. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types suitable for each location and in conformance with the following requirements:
 1. Interior Dry Locations: Sheet steel, NEMA type 1.
 2. Locations Exposed to Weather or Dampness: Cast metal, NEMA type 3R.
 3. Wet Locations: NEMA type 4X enclosures.
- B. Through-wall boxes are not permitted. Offset back-to-back boxes in the same wall not less than 3". If boxes are in fire rated partitions, offset boxes a minimum of 24" or provide fire rated "putty pads" on boxes. If boxes are in the same stud cavity and open to opposite sides of the wall, provide "putty pads" on boxes.
- C. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types suitable for each location, except as otherwise indicated.

3.8 OUTLET BOX INSTALLATION

- A. Install items where indicated and where required to suit code requirements and installation conditions.
- B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
- C. Support and fasten items securely in accordance with Division 26 Section "Supporting Devices."
- D. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.
- E. Remove sharp edges where they may come in contact with wiring or personnel.
- F. Mounting: Mount outlet boxes for switches with the long axis vertical. Mount boxes for receptacles vertically. Three or more gang boxes shall be mounted with the long axis horizontal. Locate box covers or device plates so they will not cover different types of building finishes either vertically or horizontally. Locate boxes for switches near doors on the side opposite the hinges.

- G. Ceiling Outlets: For fixtures, where wiring is concealed, use outlet boxes 4-inches square by 1-1/2 inches deep, minimum.
- H. Protect outlet boxes to prevent entrance of plaster and debris. Thoroughly clean foreign material from boxes before conductors are installed.

END OF SECTION 260110

SECTION 260115 – UNDERGROUND DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

- A. This section covers the installation of direct bury and concrete encased underground ducts.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70 “National Electrical Code” for components and installation.
- B. Comply with IEEE C2 “National Electrical Safety Code” for components and installation.
- C. Listing and Labeling: Provide products specified in this Section that are UL listed and labeled.
- D. Comply with NECA / NEMA 605, “Recommended Practice for Installing Underground Non-metallic Utility Duct.”

PART 2 - PRODUCTS

2.1 LOW VOLTAGE POWER SYSTEMS (600V OR LESS)

- A. Provide PVC Schedule 40 ducts, direct buried or concrete encased, as indicated on plans.

2.2 CONNECTORS AND COUPLINGS

- A. Provide proper connectors and couplings for the ducts per manufacturer’s recommendations.

2.3 CONCRETE

- A. 3000 psi minimum 28 day compressive strength. Comply with American Concrete Institute Publications.
- B. Concrete for high voltage ducts shall have dark red color tint throughout, or spread red coloring on top of concrete immediately after placement.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate all locations, size and details of this installation with the existing site conditions.
- B. Work with extreme care near existing ducts, conduits, cables and other utilities to avoid damaging them.

3.2 INSTALLATION

- A. Clearances between each conduit and/or duct shall not be less than 3 inches.
- B. Install concrete or plastic spacers to insure maintenance of the above clearances during concrete pours.

- C. Install tie wires to prevent displacement of the ducts and conduits during pouring of concrete. Do not use tie wires as substitutes for the spacers.
- D. Prior to installing cables in new and existing underground raceways, thoroughly clean the raceways with suitable mandrels or swabs.

3.3 TERMINATIONS

- A. Terminate the ducts and conduits with the proper manufactured end bells.
- B. Seal the ducts and conduits at building entrances and at outdoor terminations for equipment, including spare ducts and conduits, with a suitable compound to prevent the entrance of moisture and gases. Install Tyco Electronics "TDUX" or equivalent product in all conduits at building entrance.
- C. Where new ducts, conduits and concrete envelopes are to be joined to existing manholes, hand holes, ducts, conduits and concrete envelopes, make the joints with the proper fittings and fabricate the concrete envelopes to insure smooth, durable transitions.

3.4 TRENCHES

- A. Cut the trenches neatly and uniformly.
- B. Pitch the trenches uniformly without pockets, not less than 4 inches per 100 feet, toward manholes or both ways from high points between manholes. Avoid pitching the ducts toward buildings wherever possible.

3.5 CONCRETE WORK

- A. Concrete envelopes, when indicated, shall be as follows:
 - 1. Shall extend not less than 3 inches beyond the outside walls of the outer ducts and conduits.
 - 2. Top not less than 24 inches below finished grade in lawn and other non-paved areas.
 - 3. Top not less than 30 inches below finished grade at roads and other paved surfaces.
- B. Pour concrete beds in the trenches, not less than 3 inches thick, and allow the concrete to set before placing the ducts or conduits.

END OF SECTION 260115

SECTION 260120 - CONDUCTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

- A. This section includes conductors, wires, cables and associated splices, connections and terminations for wiring systems rated 600V or less.

1.3 QUALITY ASSURANCE

- A. Conductors and cable shall conform to UL, NEMA WC70, NECA 120, NFPA 70 and ICEA S-95-658 requirements.
- B. Comply with NECA 120, "Standard for Installing Armored Cable (Type AC) and Metal Clad Cable (Type MC)."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Wires and Cables

1. American Insulated Wire Corp.; Leviton Manufacturing Co.
2. BICC Brand-Rex Company
3. Carol Cable Co., Inc.
4. Service Wire Company
5. Southwire Company
6. Alflex Corporation
7. AFC Cable Systems, Inc.
8. Colonial Wire and Cable Co., Inc.
9. General Cable Corporation
10. Okonite Company
11. Pirelli Cable Company
12. Superior Essex

B. Connectors for Wires and Cables

1. AMP Inc.
2. General Signal; O-Z/Gedney Unit
3. Tyco Electronics Corporation
4. Square D Co.; Anderson
5. 3M Company; Electrical Products Division
6. AFC Cable Systems, Inc.
7. Erico, Inc.
8. Hubbell Power Systems, Inc.
9. ILSCO Corporation
10. Thomas & Betts Corporation

2.2 CONDUCTORS

- A. Provide copper conductors with insulation rated for 600 volts, type THHN or THWN for interior use and type XHHW-2 for exterior installation.

- B. Conductors No. 10 AWG and smaller shall be solid. Conductors No. 8 AWG and larger shall be stranded.
- C. Provide single copper conductors throughout. Provide No. 12 AWG minimum branch circuit wire size. Provide No. 14 AWG for control circuits, unless otherwise specified or required by overcurrent protection.
- D. For exterior feeders or branch circuits, provide Type XHHW-2 conductors installed in underground raceways.

2.3 CONNECTORS FOR CONDUCTORS

- A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for application and for service indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

2.4 CABLES

- A. Type MC cable shall be THHN/THWN insulated circuit conductors with full size insulated ground wire enclosed within flexible metal covering. Metal covering shall be galvanized steel.
- B. Type AC cable shall have THHN/THWN insulated circuit conductors with bonding conductor enclosed with flexible metal covering. Metal covering shall be galvanized steel.
- C. Connectors and fittings for type MC and type AC cable shall be manufactured and listed for that purpose.

2.5 TYPE NOT PERMITTED

- A. The following wire and cable types are not permitted to be used:
 - 1. BX
 - 2. NM/NME
 - 3. TW

PART 3 - EXECUTION

3.1 CONDUCTOR SIZES AND TYPES

- A. Low voltage wire and cable for audio, signal and control cables are specified elsewhere in this Specification.
- B. Any 120V lighting and receptacle circuit, whose home run length from panel to first fixture or device exceeds one hundred (100) feet for 120V circuits, shall not be less than 10 gauge for the entire length of run, to minimize voltage drop.
- C. Wire size and insulation type entering any lighting fixture or equipment shall be as recommended by the manufacturer and as minimally required by the codes. Where no recommendation is given by the manufacturer, the wire size and insulation type shall meet the minimum rating of the wiring or terminations used in the fixture or equipment.
- D. Conductor sizes for motors, equipment and feeders shall be as indicated. See Schedules on drawings.
- E. Type AC cable may be used only for flexible connections to recessed lighting fixtures from separately mounted outlet boxes. Length shall not exceed six feet.
- F. Type MC cable may be used only for flexible wiring from outlet boxes mounted above accessible ceilings to wall switches and wall mounted 120V duplex receptacles. Junction box where flexible cable starts shall be part of branch circuit conduit system located in accessible

ceiling space. MC cable shall not be used for homeruns. Use EMT conduit for all homeruns and connection to Electrical Panels.

3.2 INSTALLATION

- A. Wire and cable shall be installed in conduit, duct, wireway, surface raceway or other raceway specified. No conductors or cables shall be installed in conduits, ducts or raceways until the raceway system has been completed and free of any dirt or water. When installing conductors, exercise due care to prevent damage to conductors and insulation.
- B. Wire 10 gauge or smaller shall be spliced, tapped or joined in outlet or junction boxes with solderless spring-type connectors. Bakelite insulated wire nuts are not approved.
- C. Conductors 8 gauge and larger shall be terminated using bolted pressure or compression type connectors. They shall be specifically designed for use with the type conductors being installed in compliance with manufacturer's recommendations.
- D. Uninsulated splices, joints and free ends of conductors shall be covered with rubber and friction tape or high dielectric polyvinylchloride Scotch No. 33 Plus electrical tape.
- E. Feeder cables shall be continuous from origin to panel or equipment termination without splices in intermediate pull or splice boxes or raceway runs. Where taps and splices are necessary, they shall be made in approved splice boxes with suitable compression type connectors.
- F. Fixture and branch circuit wiring joints in exterior junction and outlet boxes shall be made with waterproof connectors rated at 600 volts maximum (1,000 volts when enclosed in fixture or sign).
- G. Exterior branch circuit conductor splices below grade shall occur only in gasketed weatherproof junction boxes. Use split bolt connector with Okonite self-fusing tape #35, wrapped by Scotch #33 Plus tape and sealed with 3M High Gel Re-enterable Encapsulant #8882.
- H. Coordinate wire installation with other work. Support cables in accordance with Section 260190.
- I. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary. Perform pull tension calculations and do not exceed those values.
- J. Use pulling means including fish tape, cable, rope and basket weave wire/cable grips which will not damage cable or raceways. Do not use rope hitches for pulling attachment to wire or cable. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- K. Keep conductor splices to a minimum. Provide splice and tap connectors which possess better mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors which are compatible with conductor materials.
- L. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Make terminations so there is no bare conductor at the terminal. Bundle conductor sizes #12 and #10 together. Bundle individual circuits larger than #10 separately.
- M. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.
- N. Connect wiring devices, light fixtures, panelboard devices and other electrical equipment to the wiring systems as indicated and in accordance with manufacturer's instructions.

- O. Leave a minimum of 12" pigtail at each outlet for termination purposes.
- P. Home runs shall be in conduit. Not more than three (3) branch circuits may be grouped in one (1) homerun to a branch circuit panelboard. Derate conductors per NEC requirements and count the neutral as a current carrying conductor.
- Q. Through-wiring is not permitted for recessed lighting fixtures. Each recessed lighting fixture shall be connected by flexible metal-clad cable to a separate junction box mounted above ceiling, which may serve no more than four fixtures. This flexible cable shall be Type MC or AC cable, with ground.
- R. Through-wiring is permitted for continuous rows of surface-mounted or pendant-mounted light fixtures. Fixture rows, pendant or surface-mounted, shall be fed through a flush ceiling-mounted outlet box. Branch circuit conductors for through-wiring shall have a minimum temperature rating of 90°C, or higher, if required by lighting fixture manufacturer.
- S. Install conductors with compression type motor pigtail connectors of sizes as required for motors and mechanical equipment. Connectors shall be rated for 600V, 90 degrees C, and tin plated copper with the thermoplastic elastomer insulator.
- T. Where lugs or termination points are not sized to accommodate the wire size specified or are not listed for the conductor material, provide pin connectors rated for use with copper/aluminum conductors and terminate with a tool and die size recommended by the connector manufacturer.

3.3 FIELD QUALITY CONTROL

- A. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Visually inspect all terminations are tight and proper and materials installed are in accordance with the specification section.
- B. Prior to energizing test wires and cables for electrical continuity and for short-circuits and proper phase relationship. Verify conductors are appropriately color coded.
- C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.
- D. Torque all connections/lugs in accordance with manufacturer instructions. Where torque valves are absent, follow ANSI/NETA Standard for acceptance testing specifications.

3.4 COLOR CODING FOR PHASE IDENTIFICATION

- A. Color code secondary service, feeder and branch circuit conductors with factory applied color as follows:

<u>208Y/120 Volts</u>	<u>Phase</u>	<u>480Y/277 Volts</u>
Black	A	Yellow
Red	B	Brown
Blue	C	Orange
White	Neutral	White/Gray Stripe
Green	Ground	Green

- B. Where the local jurisdiction requires, color code 480Y/277 phase C conductor purple.
- C. Phase conductors with special marking, such as in type MC cable assemblies, shall be acceptable.
- D. Conductors manufactured in only one color shall be marked with colored tape at each termination to identify each conductor as phase, neutral or ground.

- E. Ungrounded conductors supplied from more than one nominal voltage system shall be separately identified where accessible.

END OF SECTION 260120

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SECTION 260140 – WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers wiring devices, including floor boxes and outlets, and multi-outlet surface metal raceways.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.3 RELATED SECTIONS

- A. Provide boxes and raceways as specified in Section 260110 - RACEWAYS, FITTINGS AND BOXES.

1.4 QUALITY ASSURANCE

- A. Wiring devices shall comply with NEMA Standards WD-1 and WD-6.
B. Comply with NECA 130, "Standard for Installing and Maintaining Wiring Devices."

PART 2 - PRODUCTS

2.1 SWITCHES

- A. Switches shall be specification grade, quiet operating type rated 120/277V, 20 amperes, color as selected by architect, types as listed below:

	<u>HUBBELL</u>	<u>COOPER</u>	<u>P&S</u>	<u>LEVITON</u>
Single Pole	CSB120-*	2221	PS20AC1-*	1221-2*
Double Pole	CSB220-*	2222	PS20AC2-*	1222-2*
Three Way	CSB320-*	2223	PS20AC3-*	1223-2*
Four Way	CSB402-*	2224	PS20AC4-*	1224-2*
Key-Single Pole	HBL1221L	2221L	PS20AC1*L	1221-2L
Pilot Light (1P)	HBL1221PLC	2221-PL	PS20AC1CPL	1221-PL

- B. Switches shall comply with UL Standard 20, and with Federal Specification W-S.
C. Manufactured modular connector devices equivalent to Pass Seymour Plug Tail shall be acceptable.

2.2 WALL DIMMERS

- A. Dimmers shall be specification grade UL Listed (File #E-47967), designed for the demands of a commercial application.

Cooper	SKYE SF10P-W	1200W	LED
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2.3 RECEPTACLES

- A. Receptacles shall be NEMA 5-20R, grounding type, rated 20 amperes, 125 volt, color as selected by architect (provide gray for WP cover plates), types as listed below:

	<u>HUBBELL</u>	<u>COOPER</u>	<u>P&S</u>	<u>LEVITON</u>
Duplex	HBL5362-*	5362*	5362-A*	5362-*
Single	HBL5361-*	5361*	5361-*	5361-*

Ground Fault Ground Fault Tamper Resistant (Ground fault receptacle shall be of self-test diagnostic with red and green indicator lights.) Ground Fault Weather Resistant Duplex Tamper Resistant Duplex Isolated Ground	GFST20* GFR5362SG* GFR5362SG* HBL8300SG*-A IG5362*	VG F20* --- --- --- IG5362RN	2096* 2096TR* 2095TRWR* TR5362* IG5362*	S7899-* S7899-* WT899-KW* SG63H-* IG5362
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- B. Manufactured modular connector devices equivalent to Pass Seymour Plug Tail shall be acceptable.
- C. Receptacles with USB charger shall be rated 20A circuit feed through, 125V, color as selected by architect (provide decorator type cover plate.) USB charger rated 3A, 5VDC.

Duplex with USB Charger: HUBBELL Cat #: USB15X2*.

- D. Dryer receptacle shall be NEMA 14 30R grounding type, rated 30 amperes, 3 pole, 4 wire, 125/250 volt black color, types as listed below:

	<u>HUBBELL</u>	<u>COOPER</u>	<u>P&S</u>	<u>LEVITON</u>
Dryer Outlet	RR430F	1257	3864	278

- E. Range receptacle shall be NEMA 14-50R grounding type, rated 50 amperes, 3 pole, 4 wire, 125/250 volt black color types as listed below:

	<u>HUBBELL</u>	<u>COOPER</u>	<u>P&S</u>	<u>LEVITON</u>
Range Outlet	RR450F	1258	3894	279

- F. Receptacles shall comply with UL Standard 498 Federal Specification WC596F.

2.4 COVERPLATES

- A. Provide coverplates of the appropriate type and size on all devices.
- B. Coverplates shall be the same color as the device, smooth thermoplastic nylon, as manufactured by Cooper, P&S, Hubbell or Leviton.
- C. Device plates that will contain pilot lights shall be metal, smooth, jumbo type.
- D. Where devices are installed in exposed fittings or boxes, use Appleton "FSK" covers.
- E. Install blank covers on boxes without devices.
- F. Weatherproof Cover Plates (WP Designation)
 1. Receptacles in Damp Locations shall have an enclosure for the receptacle that is weatherproof when the receptacle is covered (attachment plug cap not inserted and receptacle covers closed).
 2. Receptacles in Wet Locations shall have an enclosure that is weatherproof whether or not the attachment plug cap is inserted. An outlet box hood installed for this purpose shall be listed and shall be identified as "extra-duty".
 3. Vertical mounting: Cast aluminum mounted on FS/FD box, suitable for GFI receptacle: TayMac MX3200, Hubbell HBL WP26M, P & S WIUC10CABRV, Cooper WIUMV-1.
 4. Horizontal Mounting: Cast aluminum, mounted on FS/FD box, suitable for GFI receptacle: TayMac MX3300, Hubbell WP26M, P & S WIUC10CABRH, Cooper WIUMH-1W.

2.5 SPECIAL USE OUTLETS

- A. Clock outlets shall be specification grade, grounding type rated at 15 amperes, equal to A.H. #452, P&S #53733-SS or Hubbell #5235.
- B. Provide special purpose outlets as indicated on the drawings.

2.6 MULTI-OUTLETS SURFACE RACEWAY

- A. Multi-outlet surface metal raceway shall be Wiremold or Hubbell 3000 as indicated on the drawings. Receptacles and device plates shall be as specified above. Finish shall be manufacturer's standard. Length shall be as indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies plumb and secure.
- B. Install wall plates when painting is complete.
- C. Arrangement of Devices: Except as otherwise indicated, mount flush, with long dimension vertical and grounding terminal of receptacles on top. Group adjacent devices under single, multi-gang wall plates.
- D. Protect devices and assemblies during painting.
- E. Adjust location where floor service outlets and telephone/power service poles are installed to suit the indicated arrangement of partitions and furnishings.
- F. Receptacles shall be repositioned not more than 10 feet from location indicated, when so directed by the Architect, at no cost to the owner.
- G. Barriers: Provide compartment and/or outlet box barriers between device for the following conditions:
 - 1. Where devices, receptacles or switches are served by normal and emergency power sources.
 - 2. Where devices operate at different voltage.
 - 3. Multiple wall switches operating at 120V and 277V and multiple 277V switches.
- H. Install exterior GFI receptacles horizontally, with weatherproof cover plate.

3.2 MOUNTING HEIGHTS TO CENTERLINE OF DEVICE

- A. Receptacles: 18" above floor.
- B. Wall switches: 46" above floor.
- C. Counter Receptacles: 6" above back splash.

3.3 GROUNDING

- A. Receptacle ground terminal: Connect ground terminal to grounding conductor routed with circuit conductors.

3.4 FIELD QUALITY CONTROL

- A. Testing: Test wiring devices for proper polarity and ground continuity.
- B. Test ground-fault circuit interrupter operation according to manufacturer recommendations.
- C. Replace damaged or defective components.

3.5 CLEANING

- A. General: Internally clean devices, device outlet boxes and enclosures. Replace stained damaged or improperly painted wall plates or devices. Devices with drywall mud, spackle, and caulk, adhesive or other foreign material shall be considered damaged and replaced.

END OF SECTION 260140

SECTION 260150 - MOTORS AND MOTOR CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.
- B. This section covers motors and motor control devices.
- C. Comply with NECA 230, "Standard for Selecting, Installing and Maintaining Electric Motors and Motor Controllers."

PART 2 - PRODUCTS

2.1 GENERAL

- A. Unless otherwise indicated, all motors 3/4 horsepower and larger shall be connected for operation at 208 volts or 480 volts, 3 phase, and motors less than 3/4 horsepower shall be connected for operation at 115 volts, single phase.
- B. Motors. All motors shown on the drawings will be furnished and set in place under the respective section where the equipment is specified.
- C. Control devices such as aquastats, firestats, freezestats, etc., are furnished under the Mechanical Contract, and wiring from each such device to the motor starter is included in the Electrical Contract, unless specifically indicated otherwise.
- D. Control devices such as electro-pneumatic switches, thermostats, flow switches, etc., are furnished under the Mechanical Contract, and wiring from each such device to the motor starter is included in the Mechanical Contract, unless specifically indicated otherwise.
- E. Motor Controls. Unless specifically indicated otherwise, provide all power wiring, disconnects, starters, relays, pushbuttons, pilot lights, motor connections, supports, and all appurtenances required for the safe and satisfactory control of all motors.
- F. Refer to the Motor Equipment Schedule on the drawings for details.

2.2 MOTOR STARTERS

- A. Provide magnetic starters for three-phase motors. Provide manual starters for single-phase motors unless otherwise indicated. NEMA 1 enclosure is standard, but for enclosures exposed to the weather provide NEMA 3R enclosures. Square D starters are specified to establish quality and general requirements. Comparable starters manufactured by Siemens, Eaton or General Electric will be acceptable.
- B. In each magnetic starter provide:
 - 1. Cover-mounted "Start" button, cover-mounted "Hand-Off-Automatic" selector switch or "Start-Stop" pushbutton as shown on Motor Control Schedule, and manual overload reset button.
 - 2. Red "On" pilot light.
 - 3. One solid state overload relay with adjustable trip setting properly sized for the actual motor nameplate current and motor operating conditions. Multiply by 1.15 for 1.15 service factor motor. Solid state relay shall have phase loss, phase unbalance protection and shall be ambient temperature insensitive. Use heater type overload relays only in open delta or ground "B" phase systems.
 - 4. Minimum of two auxiliary contacts plus those scheduled (maximum 4).

5. Control transformer (unless otherwise indicated) for maximum control voltage of 120 VAC complete with primary and secondary overcurrent and short circuit protection.
- C. Manual Motor Starters. Provide Square D, Class 2510, 2511, 2512, single pole, complete with red "On" pilot light, toggle switch, overload relay, and manual overload reset. Provide flush mounting with stainless steel plate in finished areas and surface mounting in unfinished areas. The starter shall have a minimum rating of 1 horsepower at 240 VAC.
- D. Full Voltage Magnetic Starter. Provide Square D, Class 8538, non-reversing, sized for the horsepower and current rating of the motor. The minimum size shall be NEMA size 0.
- E. Combination Starters
 1. For indoor application, provide Square D, Class 8538 with fused or non-fused disconnect as indicated.
 2. For outdoor application, provide Square D, Class 8538(NEMA 3R) with fused or non-fused disconnect as indicated.
- F. Remote controls. Provide Square D, Class 9001, 22mm pushbuttons and selector switches, oil tight type, with red "ON" pilot light. Provide flush mounting with stainless steel plate in finished areas and surface mounting in unfinished areas. Provide momentary "Start-Stop" buttons or maintained contact three-position "Hand-Off-Automatic" selector switch, as indicated.
- G. Provide time delay relays in starters for motors 10hp or more. Set delay time for motors to start at staged times upon loss of normal power

PART 3 - EXECUTION

- 3.1 Coordinate all details pertaining to the motor control equipment with the mechanical and temperature control installation. This includes, but is not limited to: motor size, coordination of motor starter coil voltage ratings, verification and coordination of mechanical control device voltage and amp ratings, and coordination of pilot control devices such as momentary contact versus maintained contact.
- 3.2 All Temperature Control Wiring (below 100 VAC) will be provided by the Mechanical Contractor. All interlock wiring (100 VAC and above) shall be provided by the Electrical Contractor, unless otherwise indicated. See the Motor Schedule on the plans and Sequence of Controls Specification section 230965 for detailed requirements. In general, the interlock wiring is not shown on the plans, but is called out in the Motor Schedule or specifications. The Electrical Contractor is responsible for furnishing and installing all such control wiring as indicated on the Motor Schedule, even if not shown on the plans. The Electrical Contractor is also responsible for the proper electrical operation of all items on the Motor Schedule, such as correct rotation of motors, correct heater sizes, etc.
- 3.3 Provide all connections to motors, and other equipment subject to vibration, with a flexible conduit connection. Use jacketed weatherproof flexible conduit, equal to Sealtite, for motors installed in a damp or wet location. Flexible conduit shall be installed in sufficient length and with enough slack to preclude transmission of vibration.
- 3.4 All starters shall be installed less overload heaters. The Electrical Contractor shall review the motor nameplates for the full load amps. When all nameplate full load amps have been recorded, the overload heaters shall be ordered and installed. Any starters that are installed with overload heaters prior to the nameplate full load amps being available shall, if required, be changed by the Electrical Contractor at no additional cost to the Owner.

END OF SECTION 260150

SECTION 260160 – SAFETY SWITCHES

PART 1 - GENERAL

1.1 GENERAL

- A. This section covers Safety Switches.
- B. Furnish and install safety disconnect switches where indicated on the drawings, in the equipment schedules and as specified elsewhere herein.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.3 RELATED SECTIONS

- A. Fuses are covered in Section 260180, LOW VOLTAGE FUSES.
- B. Individually-mounted starters are covered in Section 260150, Motors and Motor Controls.
- C. Refer to Section 260010, Basic Electrical Materials and Methods, for Nameplates.

1.4 QUALITY ASSURANCE

- A. Switches shall be Underwriter's Laboratories, Inc., listed, and shall meet Federal Specification WS-865c and NEMA Specifications KS1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Safety Switches shall be as manufactured by Square D, Eaton, General Electric or Siemens.

2.2 SAFETY SWITCHES

- A. Disconnect safety switches shall be single-throw, positive quick-make, quick-break contact mechanism, fusible or non-fusible as indicated, heavy duty, horsepower rated, dead front, and front accessible. The switch handle shall physically indicate the ON and OFF positions. Such handles shall also be able to accept a padlock having heavy duty industrial type shackles, and be padlocked either in the ON or the OFF position. Covers shall be interlocked with the switch handles to prevent opening in the ON position. An interlock override device shall be provided to allow authorized personnel to release the interlock for inspection purposes when the switch is in the ON position. Switch ampere rating and number of poles shall be as indicated on the drawings or as required. Fuse clips shall be positive pressure cartridge type and shall accommodate the classification of fuses as indicated on the drawings and/or as specified.
- B. The disconnect handle shall be attached to the box or enclosure base, and not to the cover. Terminal lugs shall be Underwriter's Laboratories listed for copper and aluminum cables and shall be front removable. All current carrying parts shall be plated by electrolytic processes.
- C. Switch enclosures for indoor locations shall generally be NEMA 1 heavy duty, code gauge sheet steel. Switches located outdoors or in wet locations shall be NEMA 3R rain tight, code gauge galvanized steel and are identified on the drawings as weatherproof (WP). Exterior switches located at cooling towers shall be NEMA 4 watertight, stainless steel. Switches located in food service preparation and dishwashing areas shall be NEMA 4 watertight, stainless steel. Switches located in hazardous areas shall have enclosures of the proper NEMA type construction for the location and application and will be so indicated on the drawings. Enclosures shall meet Underwriter's Laboratories Standard 98, and shall be treated with a rust-inhibiting phosphate and finished in gray baked enamel paint.

- D. Heavy duty switches shall have permanently attached arc suppressors hinged or otherwise attached to permit easy access to line-side lugs without removal of the arc suppressors.
- E. Switches used in circuits having a neutral conductor shall be provided with an insulated (isolated) ground able solid neutral terminal bar.
- F. Provide auxiliary contacts in all safety switches. Auxiliary contacts shall be (2) N.O. and (2) N.C. form C type. Connect auxiliary contacts to VFD controls to shut down when circuit is opened for safety switches used with VFDs.
- G. Provide an internally mounted ground bus kit labeled for copper or aluminum ground conductors in all safety switches.

PART 3 - EXECUTION

- 3.1 Properly align Safety Switches and adequately support independent of the connecting raceways. Provide steel straps and appurtenances necessary for the support of the equipment.
- 3.2 Furnish and install fuses in fusible safety switches where required. Verify rating of installed fuses.
 - A. Comply with NECA 1, NEMA PB1.1 and PB 2.1.
 - B. Install wall mounted switches with tops at uniform height, unless noted otherwise.
 - C. Install fuses so ratings are readable in the installed position.
- 3.3 On completion of installation, vacuum dirt and debris from interiors. DO NOT use compressed air to assist in cleaning.

END OF SECTION 260160

SECTION 260190 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conduit and equipment supports.
- B. Anchors and fasteners.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.3 REFERENCES

- A. NECA 101- "Standard for Installing Steel Conduit (Rigid, IMC, EMT)."
- B. ANSI/NFPA 70 - National Electrical Code.
- C. Refer to 260025, SEISMIC RESTRAINTS Section for additional requirements.

PART 2 - PRODUCTS

2.1 Materials and Finishes: Provide adequate corrosion resistance.

2.2 Provide material, sizes and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products. System shall be adequate in tension, shear and pullout forces to resist maximum loads calculated or imposed with a minimum structural safety factor of four times the applied force. Minimum static design load shall be the weight of supported components, plus 200 lbs.

2.3 Anchors and Fasteners:

- A. Concrete structural elements: Use expansion anchors.
- B. Steel structural elements: Use beam clamps, spring steel clips, steel ramset fasteners, or welded fasteners.
- C. Concrete surfaces: Use self-drilling anchors and expansion anchors.
- D. Hollow Masonry, plaster, and gypsum board partitions: Use toggle bolts and hollow wall fasteners.
- E. Solid masonry walls: Use expansion anchors.
- F. Sheet Metal: use sheet metal screws.
- G. Wood elements: Use wood screws.

2.4 Steel strut framework: Provide 12 gauge minimum size framework similar and equivalent to B-line or Unistrut for supporting electrical enclosures where noted or where necessary for a rigid installation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation", NECA 1 and 101. Space supports as scheduled in NECA 1 where Table 1 lists maximum spacings less than those listed in NFPA 70.

- C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
- D. Do not drill or cut structural members.
- E. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- F. Install surface-mounted equipment enclosures with minimum of four anchors.
- G. In wet and damp locations use steel channel supports to stand equipment enclosures one inch off wall.
- H. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- I. Install trapeze-type supports fabricated with steel slotted support system. Secure raceways to supports with two-bolt conduit clamps.
- J. Cast anchor bolts into concrete housekeeping bases and anchor equipment. Install anchor bolts per equipment manufacturer's setting drawings, templates, diagrams, instructions and directions at required elevations.

END OF SECTION 260190

SECTION 260432 – SERVICE PANELBOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

- A. This Section includes low-voltage power service and distribution panelboards and associated auxiliary equipment rated 600 V or less.

1.3 QUALITY ASSURANCE

- A. Provide panelboard assemblies that are listed and labeled as defined in the National Electrical Code, Article 100. Service Panelboards shall meet NEC Article 110 Requirements for Electrical Installation and Article 408 Switchboards and Panelboards.
- B. Electrical Component Standard: Components and installation shall comply with NFPA 70, "National Electrical Code."
- C. NEMA Standard: Comply with NEMA Standard PB2, "Deadfront Distribution Panelboards."
- D. UL Standard: Comply with UL 891, "Deadfront Panelboards."
- E. Comply with NECA 407, "Recommended Practice for Installing and Maintaining Panelboards."
- F. Product Selection for Restricted Space: The Drawings indicate dimensions for panelboard equipment including clearances between panelboard and adjacent surfaces and items. Provide panelboards which have equal performance characteristics and which comply with indicated dimensions.
- G. Panelboard shall be UL listed and labeled for use as service entrance equipment.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
- B. Store so condensation will not occur on or in panelboards. Provide temporary heaters as required to assure avoiding condensation.
- C. Handle panelboards in accordance with NEMA Standard PB2.1, "General Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Panelboards." Use factory-installed lifting provisions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Square D Co., Schneider Electric
 - 2. Siemens Energy & Automation, Inc.
 - 3. General Electric Co.
 - 4. Eaton
- B. FABRICATION

1. The panelboard framework shall be fabricated on a die-formed steel base or base assembly consisting of formed steel and commercial channel welded or bolted together to rigidly support the entire shipping unit for moving on rollers and floor mounting. Alternately, panel can be wall or strut mounted. The framework is to be formed code gauge steel, rigidly welded and bolted together to support all coverplates, bussing, and component devices during shipment and installation. Top and bottom conduit area is to be clearly shown and dimensioned on the shop drawings. Wireways, and sides and rear, shall have removable bolt-on or screw-on cover panels. The paint finish shall be gray enamel over a rust-inhibiting phosphate primer.
2. The panelboard bus shall be either copper or tin-plated aluminum of sufficient cross-sectional area to continuously conduct rated full load current with a maximum temperature rise of 65 degrees C. The bus bars shall have minimum short circuit bracing of 50,000 RMS amps symmetrical or as indicated on the one-line diagram. Neutral busses shall be the same size and material as the phase busses. Panelboard shall be provided with a copper ground bus, which shall be bonded to the panelboard enclosure.

2.2 ENCLOSURE

- A. Type 1 building interior locations.
- B. Type 3R building exterior locations. NEMA-3R non-walk-in, sloped roof.
- C. Sections shall be aligned front and rear. Front covers shall be hinged and latched with provisions for pad locking.
- D. The panelboard enclosure shall be painted on all exterior surfaces. The paint finish shall be medium gray, ANSI #49, applied by the electro-deposition process over an iron phosphate pre-treatment.
- E. Provide with front covers that shall be screw removable with a single tool and all doors shall be hinged with removable hinge pins.
- F. Top and bottom conduit areas shall be clearly indicated on shop drawings.

2.3 UTILITY METERING COMPARTMENT

- A. The utility current transformers shall be located in a separate outdoor enclosure.

2.4 OVERCURRENT DEVICES

- A. Switches 800 amperes and less shall be quick-make, quick-break and suitable for use on the service as described for the sizes as shown on the associated drawings. The units, where applicable, shall be horsepower rated for dual-element fuses. The fusible switches shall be group mounted in panel-type construction. Each switch is to be enclosed in a separate steel enclosure. The enclosure shall employ a hinged cover for access to the fuses which shall be interlocked with the operating handle to prevent opening the cover when the switch is in the ON position. This interlock shall be constructed so that it can be released with a standard electrician's tool for testing fuses without interrupting service. The units shall have padlocking provisions in the OFF position and the operating handle position shall give positive position indication, i.e., horizontal OFF, diagonal ON.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents:
 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (5-mA trip).
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the sizes, number, ratings and conductor material as indicated on the drawings.
 - c. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of arc chutes.

2.5 RATINGS

- A. System voltage, continuous main bus amperage and short-circuit-current ratings shall be as indicated on the drawings.

2.6 NAMEPLATE

- A. Provide black plastic nameplate with 3/16" white letters showing panelboard designation, voltage and ampere ratings, short circuit ratings and manufacturer's name and sales order number.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install panelboards and accessory items in accordance with manufacturers' written installation instructions and applicable codes and standards.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels and brackets and temporary blocking of moving parts from panelboard units and components.
- C. Provide the necessary support system to satisfy the requirements of the seismic region indicated on the drawings.

3.2 CONCRETE PAD

- A. Provide a 4" high concrete pad for the service panelboard, if floor mounted.

3.3 GROUNDING

- A. Connections: As indicated. Tighten connections to comply with tightening torques specified in UL 486A and 486B.
- B. Ground equipment to main electrical ground bus indicated. Provide minimum 5-ohm ground resistance at panelboard location.

3.4 CONNECTIONS

- A. Tighten panelboard bus joint bolts and electrical connector and terminal bolts in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not stated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Upon completing installation of the system, perform the following tests:
 - 1. Make insulation resistance tests of panelboard buses, components and connection supply, feeder and control circuits.
 - 2. Make continuity tests of circuits.
- B. Visual and Mechanical Inspections: Include the following inspections and related work:
 - 1. Inspect for defects and physical damage, testing laboratory, labels and nameplate compliance with up-to-date circuit connections.
 - 2. Verify that potential transformers, including their overcurrent protection and current transformers meet specified requirements.
 - 3. Perform operational test and exercise of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 - 4. Check panelboard anchorage, area clearances and alignment and fit of components.
 - 5. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
- C. The contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study and protective device coordination study. Field settings of devices adjustments and minor modifications to equipment to accomplish conformance with an approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the owner.

3.6 CLEANING

- A. Upon completion of installation, clean interior and exterior of panelboards. Remove paint splatters and other spots, dirt and debris. Touch up scratches and mars of finish to match original finish.

3.7 PROTECTION

- A. Temporary Heating: Apply temporary heat in accordance with manufacturer's recommendation within each section of panelboards throughout periods during which the panelboard is not in a space that is continuously under normal control of temperature and humidity.

END OF SECTION 260432

SECTION 260455 – GROUNDING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

- A. This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits and systems. Grounding requirements specified in this section may be supplemented in other sections of these specifications.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for grounding rods, connectors and connection materials, and grounding fittings.
- C. Field tests and observation reports indicating and interpreting the test reports for compliance with performance requirements.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with UL 467.
- C. Listing and Labeling: Provide products specified in this section that are UL listed and labeled.
- D. Comply with NECA 331, "Standard for Building and Service Entrance Grounding and Bonding."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Chance: A. B. Chance Co
 - 2. Erico, Inc.; Electrical Products Group
 - 3. Ideal Industries, Inc
 - 4. ILSCO
 - 5. O-Z/Gedney Co
 - 6. Racco, Inc
 - 7. Thomas & Betts

2.2 GROUNDING AND BONDING PRODUCTS

- A. Governing Requirements: Where types, sizes, ratings and quantities indicated are in excess of National Electrical Code requirements, the more stringent requirements and the greater size, rating and quantity indications govern.
- B. Grounding Bus: Rectangular bar of annealed copper with tapped holes and insulated spacers.

2.3 WIRE AND CABLE GROUNDING CONDUCTORS

- A. Comply with Division 26 Section 260120, "Conductors". Conform to NEC Article 250, except as otherwise indicated, for conductor properties, including stranding.

- B. Material: Use only copper wire for both insulated and bare grounding conductors and similar materials.
- C. Equipment Grounding Conductors: Insulated with green color insulation, Type THW, THHN or THWN insulation.
- D. Grounding-Electrode Conductors: Stranded cable.
- E. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
- F. Bare Copper Conductors: Conform to the following:
 - 1. Solid Conductors: ASTM B3.
 - 2. Assembly of Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.

2.4 MISCELLANEOUS CONDUCTORS

- A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.
- B. Braided Bonding Jumpers: Copper tape, braided No. 3/0 AWG bare copper wire, terminated with copper ferrules.
- C. Bonding Straps: Soft copper, 0.05 inch (1 mm) thick and 2 inches (50 mm) wide, except as indicated.

2.5 CONNECTOR PRODUCTS

- A. Pressure Connectors: High conductivity plated units.
- B. Bolted Clamps: Heavy duty type or Hammer Lock. Acorn clamps are not acceptable.
- C. Exothermic-Welded Connections: Cadweld type, provided in kit form and selected per manufacturer's instructions.

2.6 GROUND RODS

- A. Copper-Plated Steel: 3/4" diameter, 10'-0" long.

PART 3 - EXECUTION

3.1 GENERAL

- A. The entire electrical system and all electrical equipment shall be grounded in strict accordance with the National Electrical Code and as shown on the drawings.
- B. The grounding system shall be continuous throughout the electrical system. Route along shortest and straightest paths possible. Avoid obstructing access or installing where they may be subjected to strain, impact or damage.
- C. Neutral conductors shall be continuous throughout the electrical system and shall be grounded only at the service neutral at the service switch, or at the center point of a transformer secondary winding for a separately derived system as indicated on the drawings.
- D. When the service entrance switch or switchboard has a neutral bus bar, this bus bar shall be bonded to the ground bus bar in the service entrance or switchboard.
- E. When a steel conduit contains only ground wires, the ground wires shall be bonded to the conduit at both ends of the conduit run.

- F. Service and equipment grounds to the water system piping shall be made using an approved clamp installed in an accessible location. Provide jumpers around water meters and insulated pipe connections.
- G. Cabinets, panels, boxes, appliance frames, conduits and other non-current carrying metallic objects shall be grounded as required by the National Electrical Code.
- H. Install metallic raceways mechanically and electrically secure at all joints and at all boxes, cabinets, fittings and equipment.
- I. Refer to Section 260010 - BASIC ELECTRICAL MATERIALS AND METHODS for Grounding Continuity tests required.
- J. Underground ground rod, UFER concrete encased grounding electrode, and building steel connections shall be made with exothermic welds.

3.2 APPLICATION

- A. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes and quantities of equipment grounding conductors, except where specific types, larger sizes or more conductors than required by NEC are indicated.
 - 1. Install equipment grounding conductor with circuit conductors for the items below in addition to those required by Code:
 - a. Feeders and branch circuits.
 - b. Receptacle circuits.
 - c. Single-phase motor or appliance branch circuits.
 - d. Three-phase motor or appliance branch circuits.
 - e. Flexible raceway runs.
 - f. Armored and metal-clad cable runs.
- B. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- C. Bonding conductors: Provide bonding conductors between panelboard busses where patient care areas are fed from different panels in accordance with NEC 517.14.

3.3 SEPARATELY DERIVED SYSTEMS

- A. The secondary windings of transformers constitute a separately derived system. A bonding jumper shall be used to connect the equipment grounding conductors of the separately derived system, ahead of any system disconnecting means or overcurrent device.
- B. A grounding electrode conductor shall be used to connect the grounded conductor of the separately derived system to the grounding electrode. This connection shall be made at the source of the separately derived system and ahead of any system disconnecting means or overcurrent device.

3.4 GROUNDING OF SPECIAL SYSTEMS

- A. Furnish and install a green size 6 AWG copper wire in 1/2" conduit from the data terminal board and incoming telephone service to the main switchboard ground bus. The point of connection shall be located so that it is normally visible for inspection. Provide a Telecommunications Main Grounding Busbar (TMGB) equivalent to Erico TMGB - A14L15PT at terminal boards; mount TMGB at 24" AFF and terminate #6 AWG ground conductor to it.
- B. Provide a green #6 AWG copper wire in 1/2" conduit from the Fire Alarm Control Panel to the main switchboard ground bus.

- C. Provide an equipment ground bus adjacent to the service panelboard and provide binding conductors from this bus to service ground, FACP, IDFs, Security System, Access Control System, CATV, Satellite, and all other special systems.

3.5 SYSTEM GROUNDING ELECTRODE

- A. The grounding electrode shall be as near as practicable to, and preferably in the same area as, the grounding conductor connection to the system.
- B. A metal underground water pipe, the metal frame of the building, a concrete-encased electrode and a ground ring electrode (where present) shall be bonded together to form the grounding electrode system.
- C. Where none of the above electrodes is available, the grounding electrode shall be a "Made Electrode" as per Section 250.52 of the National Electrical Code.
- D. Where a metal underground water pipe is the only grounding electrode available, it shall be supplemented by one of the grounding electrodes specified in Section 250.52 of the National Electrical Code.
- E. A single electrode which does not have a resistance to ground of 15 ohms or less shall be augmented by one additional electrode of any of the types specified in Section 250.52 of the National Electrical Code.

3.6 EQUIPMENT GROUNDING

- A. Provide an equipment bonding jumper from the grounding terminals of switches and receptacles to the grounded box that they are mounted in, unless the device is listed for self-grounding.
- B. At motors, connect the ground conductor to the conduit with an approved grounding bushing, and to the metal frame with a bolted solderless lug. Bolts, screws and washers shall be bronze or cadmium plated steel.
- C. Provide a flexible bonding strap, No. 6 AWG equivalent, across each flexible duct connection at each air handler, exhaust fan, supply fan, etc., and install to preclude vibration.
- D. Exposed non-current-carrying metal parts of transformer installations shall be connected to the equipment grounding system.
- E. Provide a flexible bonding strap, #6 AWG or equivalent, to each water heater and other piece of plumbing equipment that may become energized.

END OF SECTION 260455

SECTION 260470 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

- A. This section covers circuit breaker lighting and appliance panelboards, power circuit breaker panelboards and fusible panelboards.

1.3 QUALITY ASSURANCE

- A. Panelboards shall comply with the requirements of the National Electrical Code, NEMA, ANSI, IEEE and OSHA. Panelboards shall bear the Underwriter's Laboratories Label.
- B. Comply with NEMA Standard PB1, "Panelboards".
- C. Comply with UL Standards 67, "Panelboards" and UL50, "Cabinets and Boxes".
- D. Comply with NECA 407, "Recommended Practice for Installing and Maintaining Panelboards."

1.4 SUBMITTALS

- A. Product Data: For each panelboard and overcurrent protective device, including dimensions, ratings, finishes and components.
- B. Panelboard Schedule: Typewritten for installation in panels.
- C. Time-current curves for each overcurrent protective device.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide panelboard products of one of the following:
 1. Square D Co, Schneider Electric
 2. Eaton
 3. General Electric Co.
 4. Siemens Energy and Automation, Inc.

2.2 CIRCUIT BREAKER LIGHTING AND APPLIANCE PANELBOARDS

- A. Panelboards shall be dead front safety type equipped with circuit breakers. Each panelboard shall have an integrated short circuit withstand rating equal to the short circuit interrupting capacity of the circuit breakers. Panelboard bus structure and main lugs or main circuit breaker shall have current and voltage ratings and number of phases, poles, and wires as indicated on the drawings.
- B. Circuit breakers shall be quick-make, quick-break, bolt-on type having over-center toggle mechanisms with thermal-magnetic trips and shall be trip free. Multi-pole circuit breakers shall have common trips and a single operating handle. Handle tie bars will not be accepted. Circuit breakers shall be provided with a means for indicating a tripped position, and shall be capable of being locked in the open position. Branch circuit breakers shall be replaceable without disturbing adjacent units. Circuit breaker voltage, ampere rating, interrupting rating and number of poles shall be as indicated on the drawings. Circuit breakers shall have a minimum short-

circuit interrupting capacity of 10,000 amperes RMS for 120/208V panels and 14,000 amperes RMS for 277/480V panels. Circuit breakers shall be equipped with individually insulated, braced, and protected connectors.

1. Circuit breakers for switching fluorescent lighting circuits at panelboards shall be type SWD.
 2. Circuit breakers for equipment marked HACR Type shall be HACR type.
 3. Circuit breakers with shunt trip feature shall be 120V A.C. trip voltage.
 4. Circuit breakers with arc fault protection shall be AFCI type.
 5. Circuit breakers with ground fault protection shall be GFCI type (5mA).
 6. Circuit breakers with equipment ground fault protection shall be EPD type (30mA).
- C. UL class A (5 milliampere sensitivity) and Class B (30 milliampere sensitivity) ground fault circuit protection shall be provided on 120 VAC branch circuits as shown on the plans or in the panelboard details. This protection shall be an integral part of the branch circuit breaker which also provides overload and short circuit protection for branch circuit wiring. Tripping of a branch circuit breaker containing ground fault circuit interruption shall not disturb the feeder circuit to the panelboard. A single pole circuit breaker with integral ground fault circuit interruption shall require no more panelboard branch circuit space than a conventional single pole circuit breaker.
- D. The panel box shall be fabricated from code gauge galvanized steel. Unless otherwise indicated, panelboards shall be standard width with boxes having a minimum width of 20 inches and a maximum depth of 5-3/4 inches.
- E. The panelboard front shall be surface or flush mounted as indicated on the drawings, fabricated from cold-rolled steel, coated with rust-inhibiting primer, finished with ANSI-61 light gray baked-on enamel paint, and shall have a door equipped with concealed hinges, a semi-flush or flush lock requiring a milled key, a framed directory card with a clear plastic covering mounted on the inside of the door. At least two keys shall be provided with each panelboard and all panelboard locks shall be keyed alike. The panelboard front shall be fastened to the panel box with machine screws or other approved fastening hardware and shall not be removable with the door in the closed position.
- F. Interiors shall be equipped with bussing, circuit breakers, and adjustable means for positioning the interior within the enclosure.
- G. Main bus and circuit breaker branch bus shall be copper having 98% conductivity. Aluminum bus shall not be acceptable. Full size neutral busses shall be insulated from the panelboard. The location of the main terminations shall be determined by the entrance of the feeders to the panelboard enclosure. In those cases where the feeders pass through the panelboard assembly, extra wide gutters shall be provided.
- H. Double width panels: Where required or otherwise indicated, provide two panelboards under single front, each section with separate door and each section with similar space configuration, unless specified to be single width panel.
- I. The panelboard interior shall be provided with a ground bus, which shall be bonded to the panelboard enclosure. Provide separate isolated ground bus where indicated, or where required.
- J. The neutral bus and the ground bus shall be provided with an individual terminal or lug for each wire connected to it.
- K. Terminals for feeder conductors to the panelboard mains and neutral shall be UL listed as suitable for the type of conductor specified. Terminal for branch circuit wiring, both breaker and neutral shall be UL listed as suitable for the type of conductor specified.
- L. Bussing sequence shall be distributed phase sequence type. Bus sequence shall start at the top left phase bus of the interior for both top and bottom feed panels. Provisions or spaces for future

breakers shall be located at the bottom of the panel and be fully bussed complete with all necessary mounting hardware less the breaker. Locate next to each breaker, space, or provision an individual number permanently affixed to the panelboard. Numbering tape or painted numbers shall not be acceptable.

- M. The inside of the panel or door shall have a printed nameplate indicating the name of the panel manufacturer, shop order number, panel type, system voltage and bus ampacity. Panel shall be marked with its UL short circuit withstand ratings.
- N. Circuit breaker lighting panelboards shall be Square D type NQ or NQOD, 120/208 volts, and Square D type NF, 277/480 volts or equal by General Electric, Eaton or Siemens.
- O. The circuit breakers supplied shall be tested and listed as fully rated. This short circuit current rating shall be marked on the panelboards and shall be equal to or greater than the short circuit current available, in compliance with NEC Sections 110-22 and 240-86.
- P. Load centers are not permitted unless specifically called out in the specification and on the drawings.

PART 3 - EXECUTION

- 3.1 General: Install panelboards and accessory items in accordance with NEMA PB 1.1, "General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less" and manufacturers' written installation instructions.
- 3.2 Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289, "Application Guide for Ground Fault Circuit Interrupters."
- 3.3 Mounting: Plumb and rigid without distortion of box. Mount flush panels uniformly flush with wall finish. Top of trim shall be 74" AFF, unless noted otherwise. Mount adjacent boxes with tops aligned.
- 3.4 Circuit Directory: Provide typed directory reflective of final circuit changes required to balance panel loads.
- 3.5 Install filler plates in unused spaces.
- 3.6 Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panel into accessible ceiling space or space designated to be ceiling space in future.
- 3.7 Auxiliary Gutter: Install where a panel is tapped to a riser at an intermediate location.
- 3.8 Wiring in Panel Gutters: Train conductors neatly in groups, bundle and wrap with wire ties after completion of load balancing.
- 3.9 Install panelboards with proper code required clearances at front of and above equipment. Coordinate with other trades prior to rough-in. Verify proper wall thickness for recessed panels.
- 3.10 Each panelboard shall have a black plastic nameplate with 1/4" white letters, indicating the panel number as shown on the drawings and source of supply per NEC 408-4 (B).
- 3.11 Install floor mounted panels on a 4" nominal height concrete housekeeping pad 1" larger in both dimensions than the equipment to be set. Provide steel reinforcing per ACI recommendations.

END OF SECTION 260470

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SECTION 260475 – SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

- A. This section includes surge protective devices for low-voltage power (< 1000 volts) equipment.
- B. Related sections include the following:
 - 1. Section 260140 - Wiring Devices, for devices with integral surge protection.
 - 2. Section 260430 - Switchboards, for locations that require installation at the Service Entrance Switchboard.
 - 3. Section 260470 - Panelboards, for locations that require installation at the panel or sub-panel level.
- C. The installation shall be in conformance with NEC Article 285.

1.3 SUBMITTALS

- A. Product data: For each type of product indicated. Include rated capacities, shipping, installed and operating weights, furnished specialties, and options. Include model number, type, system voltage, phases, modes of protection, voltage protection rating (VPR) and nominal discharge current (In).
- B. Product Certifications: Signed by manufacturers of surge protective devices, certifying that products furnished comply with the following testing and labeling requirements:
 - 1. UL 1449 3rd Edition and UL 1283 listing and classifications. SPD shall bear the UL mark and shall be listed to UL 1449 3rd Edition and most recent edition of UL 1283. "Manufactured in accordance with" is not equivalent to UL listing and does not meet the intent of this specification.
- C. Maintenance Data: for surge protective devices to include in maintenance manuals specified in Division 1.
- D. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Product must be made by a company engaged in the manufacture of such devices for a minimum of five years.
- B. Source limitations: Obtain protective devices and accessories through one source from a single manufacturer.
- C. Product options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Other manufacturers' products complying with requirements may be considered by the engineer/architect greater than 14 days prior to bid. Samples may be required for approval. Devices mounted integral to the switchboard or panelboard do not meet the intent of this specification.
- D. Electrical Components, devices and accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

- E. IEEE Compliance: Comply with ANSI/IEEE C62.41-2002, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits" and test devices in accordance with ANSI/IEEE C62.45-2002, "IEEE Guide for Surge Suppressor Testing".
- F. UL Compliance: Comply with UL 1449 Rev. 3 "UL Standard for Safety for Surge Protective Devices" and UL1283 "Electromagnetic Filters".

1.5 PROJECT CONDITIONS

- A. Placing into service: Do not energize or connect service entrance equipment or panelboards to their sources until the surge protective devices are installed and connected. Do not single phase, hi-pot or megger service entrance equipment without disconnecting the surge protective device, as damage to the surge protective device may result from these procedures.
- B. Existing utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- C. Service conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Maximum continuous operating voltage: Not less than 110% of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg. F
 - 3. Humidity: 0 to 95%, non-condensing.
 - 4. Altitude: Less than 12,000 feet above sea level.

1.6 COORDINATION

- A. Coordinate location of field mounted surge suppressors to allow adequate clearances for maintenance.

1.7 WARRANTY

- A. General warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Specialty warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of surge suppressors that fail in materials or workmanship within eight years (96 months) from date of Substantial Completion or 10 years (120 months) from date of manufacture. Warranty shall include parts and labor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements of this specification listed herein, provide products by one of the following manufacturers:
 - 1. Current Technology
 - 2. Emerson Network Power / Edco
 - 3. Advanced Protection Technologies
 - 4. Eaton Corporation
 - 5. Schneider Electric
 - 6. Siemens

7. Surge Suppression Incorporated

- B. This specification is performance based, and any other vendors who desire approval to bid this project shall provide written documentation of any deviations from this specification, which shall be included in product submittal 14 days prior to bid.

2.2 SERVICE ENTRANCE SUPPRESSORS (TYPE 1)

- A. Surge protective device: The system shall be constructed using multiple surge current diversion thermally protected metal oxide varistors (TPMOVs). The surge current circuit shall be designed and constructed in a manner that ensures surge current sharing. Use of gas tubes, silicon avalanche diodes or selenium cells are unacceptable unless documentation from a nationally recognized laboratory demonstrates current sharing of all dissimilar components at all surge current levels.
- B. Product certifications: Products furnished comply with the following testing and labeling requirements: UL 1449 and UL 1283 listing and classifications including fault current rating to meet or exceed service entrance equipment.
- C. Maximum continuous operating voltage: 115% (or 125% at 120VAC) of nominal system operating voltage at 60 hz.
- D. Peak single impulse surge current capacity, in all modes. Data obtained from actual tests (per mode):
 - 1. Line to Neutral: 100,000 Amperes
 - 2. Line to Ground: 100,000 Amperes
 - 3. Neutral to Ground: 100,000 Amperes
 - 4. Line to Line: 100,000 Amperes
- E. Listed to UL 1449 3rd Edition, Voltage Protection Ratings (VPR) shall not exceed:
 - 1. 277/480 volt wye - L-N 1200, L-G 1200, N-G 1200, L-L 1800
 - 2. 120/208 volt wye - L-N 800, L-G 800, N-G 800, L-L 1200
- F. Nominal Discharge Current Rating (In): 20 kA.
- G. Integral EMI/RFI filter for high frequency noise (10 kHz to 100 mHz) attenuation.
- H. Features to include:
 - 1. LED indicator lights for power and protective status for each mode.
 - 2. Fault current UL tested and labeled for 100 kAIC.
 - 3. NEMA type 4, 4X, or 12 enclosure.
 - 4. Monitoring with audible alarm, including test and silence switch and form "C" alarm relay.
 - 5. SPD will have a warranty period as stated above with five (5) years of free replacement.

2.3 PANELBOARD SUPPRESSORS (TYPE 1 OR 2)

- A. Provide Type 1 suppressors at service entrance locations.
- B. Surge protective device: The system shall be constructed using multiple surge current diversion thermally protected metal oxide varistors (TPMOVs). The surge current circuit shall be designed and constructed in a manner that ensures surge current sharing. Use of gas tubes, silicon avalanche diodes or selenium cells are unacceptable unless documentation from a nationally recognized laboratory demonstrates current sharing of all dissimilar components at all surge current levels.

- C. Product certifications: Products furnished comply with the following testing and labeling requirements: UL 1449 3rd Edition and UL 1283 listing and classifications including fault current rating to meet or exceed panelboard.
- D. Maximum continuous operating voltage: Between 115% (or 125% at 120VAC) of nominal system operating voltage at 60 HZ.
- E. Peak single impulse surge current capacity all modes. Data obtained from actual tests (per mode):
 - 1. Line to Neutral: 50,000 Amperes
 - 2. Line to Ground: 50,000 Amperes
 - 3. Neutral to Ground: 50,000 Amperes
 - 4. Line to Line: 50,000 Amperes
- F. Listed to UL 1449 3rd Edition, Voltage Protection Ratings (VPR) as follows:
 - 1. 277/480 volt wye - L-N 1,200, L-G 1,200, N-G 1,200, L-L 1800
 - 2. 120/208 volt wye - L-N 800, L-G 800, N-G 800, L-L 1200
- G. Nominal Discharge Current Rating (In): 20 kA.
- H. Integral EMI/RFI filter for high frequency noise (10 kHz to 100 mHz) attenuation.
- I. Features to include:
 - 1. LED indicator lights for power and protective status for each mode.
 - 2. Fault current UL tested and labeled for 100 kAIC.
 - 3. NEMA type 3R, 4, 4X, or 12 enclosure.
 - 4. SPD will have a warranty period as stated above with five (5) years of free replacement.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

- A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Provide multi-pole, 60- amp (or as recommended by manufacturer) overcurrent protective device as a dedicated disconnect for the SPD at service entrance location, unless otherwise indicated on drawings.
- C. Install devices for service entrance and panelboards, as indicated per electrical drawings, with conductors between suppressor and points of attachment as short and as straight as possible. Do not exceed manufacturer's recommended lead length.
- D. Provide multi-pole, 30 amp (or as recommended by manufacturer) overcurrent protective device as a dedicated disconnect for the SPD at panelboard locations, unless otherwise indicated on drawings.
- E. Mount suppressor as close as possible to switchgear and panelboard point of connection. Do not mount internal to switchgear or panelboards to facilitate ease of future maintenance and/or replacement. Installer may reasonably rearrange OCPD location from that shown on drawing to ensure the shortest and straightest possible leads to SPD's.

3.2 CONNECTIONS

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

3.3 FIELD QUALITY CONTROL

- A. Testing: Engage a qualified testing agency to perform the following field quality control testing:
 - 1. After installing the surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements. Verify service and separately derived system neutral-to-ground bonding jumpers per NEC.
 - 2. Complete start-up checks and voltage verifications according to manufacturer's written instructions.
 - 3. Perform visual and mechanical inspection on each unit. Certify that units are installed per manufacturer's recommendations.
- B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

3.4 DEMONSTRATION

- A. Engage a manufacturer's representative to demonstrate proper operation of the system and to train owner's maintenance personnel in proper evaluation of suppressor condition and procedure to repair or replace defective devices.
 - 1. Review operation and maintenance manuals.
 - 2. Review performance specifications of devices supplied to show they comply with specifications herein.
 - 3. Schedule training with Owner, through Architect or General Contractor, with at least seven days advance notice.
 - 4. Contractor shall provide letter to owner that states units are installed per manufacturer's recommended installation procedures and system is functioning properly and warranty is initiated.

END OF SECTION 260475

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SECTION 260485 - CONTACTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

- A. This section covers multi-pole lighting contactors for controlling branch lighting circuits.

1.3 QUALITY ASSURANCE

- A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
- B. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
- C. ANSI/NFPA 70 - National Electrical Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Lighting Contactors
 - 1. Square D
 - 2. General Electric
 - 3. Siemens
 - 4. Eaton
 - 5. ASCO

2.2 MULTI-POLE LIGHTING CONTACTORS

- A. Description: NEMA ICS 2, magnetic lighting contactor. Square D Class 8903 Type L, Electrically Held.
- B. Configuration: Electrically Held, 3 wire control, unless otherwise indicated.
- C. Coil voltage: 120 volts, 60 hertz unless otherwise indicated. All lighting contactors shall be provided with separate control as standard.
- D. Number of poles shall be as called out on the drawings.
- E. Contact ampere rating shall be 30 ampere fluorescent lighting rating and 20 ampere tungsten lighting rating. Contacts shall be Silver-Cadmium-Oxide double break contacts.
- F. Enclosure: ANSI/NEMA ICS 6, Type 1 or 3R as indicated. Provide bolt-on conduit hubs for NEMA 3R enclosures.
- G. Accessories: Remote on - off selector switch Square D Class 9001, KYK 221 10 ampere, 600 volt maximum surface control switch.

PART 3 - EXECUTION

- 3.1 Properly align contactors and adequately support independent of the connecting raceways. Provide steel straps and appurtenances necessary for the support of the equipment.
- 3.2 Furnish and install remote control switches as indicated on the drawings.

END OF SECTION 230485

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SECTION 260500 – INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.
- B. Section 260000 - Electrical General Conditions
- C. Section 260010 - Basic Electrical Materials and Methods
- D. Section 260025 - Seismic Restraints

1.2 SUMMARY

- A. Furnish and install new lighting fixtures as shown on the drawings and as specified herein.

1.3 QUALITY ASSURANCE

- A. Fixtures and components shall be U.L. listed and meet applicable national and local code requirements for the particular application. Fixtures shall bear the UL label.
- B. Comply with applicable ANSI, UL and NEMA standards including, but not limited to, the following:
 - 1. NECA / IESNA 500, "Standard for Installing Indoor Lighting Systems."
 - 2. NEMA SSL-1-10, "Electronic Drivers for LED Devices, Arrays, or Systems."

PART 2 - PRODUCTS

2.1 GENERAL

- A. Lighting equipment is shown in the fixture schedule on the drawings to establish general requirements. The fixture manufacturers' catalog numbers are not to be construed as all inclusive. Equivalent products manufactured by Columbia, Cooper, Daybrite, Hubbell, Kurt Versen, Lithonia, Lightolier, Prescolite or Williams are considered equivalent. Furnish and install accessories or hardware required for a complete installation. Light fixtures shall be equipped with proper accessories, lenses, louvers, reflectors, shields, hangers, clips, frames, and other components essential for proper installation in or on walls, ceilings or other construction features, and shall be properly painted for protection and preservation appropriate to the place installed.
- B. Refer to the Room Finish Schedule on the Architectural drawings to verify the type of ceiling construction. Fixtures specified in the Fixture Schedule are based on the ceiling construction contemplated at the time of design. Final ceiling construction may be different than the type specified. EC shall confirm the ceiling construction with the General Contractor and Owner's Representative prior to construction. Provide fixtures with the proper hardware for installation in or on the specified ceiling.
- C. All fixtures shall bear a U.L. Listing.

2.2 FIXTURES AND FIXTURE COMPONENTS

- A. Metal Parts: Free from burrs, sharp corners and edges along with any metal parts shall be painted after fabrication.
- B. Sheet Metal Components: Steel, except as indicated. Formed and reinforced to prevent warping and sagging.

- C. Doors, Frames and Other Internal Access: Smooth operating, free from light leakage under operating conditions and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers and other pieces to prevent accidental falling during relamping and when secured in operating position. Door frames shall have captive spring latches.
- D. Reflecting Surfaces: Minimum reflectance as follows, except as otherwise indicated:
 - 1. White Surfaces: 70 percent
 - 2. Specular Surfaces: 80 percent
 - 3. Diffusing Specular Surfaces: 75 percent
 - 4. Laminated Silver Metalized Film: 90 percent
- E. Lenses, Diffusers, Covers and Globes: 100 percent virgin acrylic plastic or water white, annealed crystal glass, except as otherwise indicated.
 - 1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat and UV radiation.
 - 2. Lens Thickness: 0.125 inch (3mm) nominal; except where greater thickness is indicated.
- F. Finishes:
 - 1. Manufacturer's standard, except as otherwise indicated, applied over corrosion-resistant treatment or primer, free of streaks, runs, holidays, stains, blisters and similar defects.
 - 2. Finish applied on metal surfaces after forming or fabrication.

2.3 LED LIGHT FIXTURES

- A. General
 - 1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
 - 2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant and Design Lights Consortium Qualified Products.
 - 3. LED drivers shall include the following features unless otherwise indicated:
 - a. Minimum efficiency: 85% at full load.
 - b. Minimum Operating Ambient Temperature: -20° C. (-4° F.)
 - c. Input Voltage: 120 - 277V (±10%) at 60 Hz.
 - d. Integral short circuit, open circuit, and overload protection.
 - e. Power Factor: = 0.95.
 - f. Total Harmonic Distortion: = 20%.
 - g. Comply with FCC 47 CFR Part 15.
 - 4. LED modules shall include the following features unless otherwise indicated:
 - a. Comply with IES LM-79 and LM-80 requirements.
 - b. Minimum CRI 80 and color temperature 4100K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.
 - c. Minimum Rated Life: 50,000 hours per IES L70.
 - d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.
 - e. Minimum luminaire efficacy of 85 lumens per watt.
- B. LED Downlights:
 - 1. Housing, LED driver, and LED module shall be products of the same manufacturer.
- C. LED Troffers:
 - 1. LED drivers, modules, and reflector shall be accessible, serviceable, and replaceable from below the ceiling.

2. Housing, LED driver, and LED module shall be products of the same manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures shall be installed in accordance with manufacturer's recommendations, instructions contained herein or on the drawings and field conditions.
 - B. Locations of fixtures, unless specifically dimensioned on the architectural or electrical plans, may be scaled from the plans and adjusted as required to meet job conditions.
 - C. Locations of light fixtures on the electrical plans are diagrammatic. Refer to Architectural Reflected Ceiling drawings for dimensional data, location and reference data including work or other trades. Coordinate installation of lighting fixtures with those drawings.
 - D. Provide necessary accessories required for the support or mounting of fixtures. Where necessary, provide bridging between structural members. No fixtures shall be supported directly from the ceiling tiles or from duct work, piping or work of other trades.
 - E. Recessed fixtures shall be mounted with flanges tight to the finished ceilings. Provide drywall flanges for fixtures installed in drywall ceilings.
 - F. Surface and suspended fixtures shall be securely mounted to the structural system, the ceiling superstructure, or to supporting members. Surface fixtures shall be mounted in proper alignment with the ceiling. Suspended fixtures shall be mounted from vertical supports. Swivel type hangers or sloped ceiling adapter cones shall be provided on sloping ceilings.
 - G. Recessed LED fixtures shall be independently supported with a minimum of two metal channels spanning ceiling tees or ceiling support steel channels. No fixture shall be supported directly from the ceiling tile.
 - H. Support for Recessed and Semi-Recessed Grid-Type LED Fixtures: Units may be supported from suspended ceiling support system with support wires at opposite corners of the fixture attached to building structure and four (4) grid clips.
 1. Fixtures of Sizes Less than Ceiling Grid: Center in acoustical panel. Support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees. Do not support fixtures by ceiling acoustical panels.
 - I. Wall mounted fixtures shall be securely mounted with a minimum of two screws to the wall or to studs or framing within the wall to prevent the possibility of movement or misalignment.
 - J. Install remote mounted ballasts in a ventilated enclosure, which shall be secured to the building structure with vibration isolating mountings. Connections shall be thru flexible conduit. Ballasts shall be mounted in a manner which will promote heat transfer to the housing.
 - K. Adjustable fixtures shall be aimed as directed by the Architect and/or Engineer.
- 3.2 Prior to substantial completion, clean fixture lenses and reflectors. Replace or repair damaged or blemished fixtures.
- 3.3 FIELD TESTS
- A. Test emergency lighting by interrupting power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

END OF SECTION 260500

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SECTION 260525 – EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.

1.2 SUMMARY

- A. This Section includes exterior lighting fixtures, lamps, ballasts, drivers, pole standards and accessories.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Submit Product Data describing fixtures, lamps, ballasts, poles and accessories. Arrange Product Data for fixtures in order of fixture designation. Include data on fixtures, poles, accessories, finishes and the following:
 - 1. Outline drawings indicating dimensions and principal features of fixtures and poles.
 - 2. Electrical Ratings and Photometric Data: Certified results of independent laboratory tests for fixtures and lamps. Include photometric plans indicating footcandle levels on site plan at a 10'x10' grid.
 - 3. Wind Resistance Calculations: Certified by a registered professional engineer.
 - 4. Shop Drawings detailing nonstandard fixtures and poles and indicating dimensions, weights, method of field assembly, components and accessories.
 - 5. Anchor-Bolt Templates: Keyed to specific poles and certified by manufacturer.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL.
- B. Comply with ANSI C2.
- C. Comply with NECA / IESNA 501, "Standard for Installing Exterior Lighting Systems."

1.5 STORAGE AND HANDLING OF POLES

- A. General: Store poles on decay-resistant treated skids at least 12 inches (300 mm) above grade and vegetation. Support pole to prevent distortion and arrange to provide free air circulation.
- B. Metal Poles: Retain factory-applied pole wrappings until just before pole installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide the products specified in Lighting Fixture Schedule shown on drawings. Equivalent products manufactured by Gardco, Cooper, Hubbell, Kim, Lithonia and Widelite will be acceptable.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

- A. Metal Parts: Free from burrs, sharp edges and corners.

- B. Sheet Metal Components: Corrosion-resistant aluminum, except as otherwise indicated. Form and support to prevent warping and sagging.
- C. Housing: Rigidly formed, weather- and light-tight enclosures that will not warp sag or deform in use. Provide filter/breather for enclosed fixtures.
- D. Doors, Frames and Other Internal Access: Smooth operating, free from light leakage under operating conditions and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange for door opening to disconnect ballast.
- E. Exposed Hardware Material: Stainless steel.
- F. Reflecting Surfaces: Minimum reflectance as follows, except as otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- G. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor mounting in fixture doors.

2.3 FIXTURE SUPPORT COMPONENTS

- A. Pole-Mounted Fixtures: Conform to AASHTO LTS-4.
- B. Wind-load strength of total support assembly, including pole, arms, appurtenances, base and anchorage, is adequate to carry itself plus fixtures indicated at indicated heights above grade without failure, permanent deflection or whipping in steady winds of 100 mi./h (160 km/h) with a gust factor of 1.3.
- C. Arm, Bracket and Tenon Mount Materials: Match poles' finish.
- D. Mountings, Fastenings and Appurtenances: Corrosion-resistant items compatible with support components. Use materials that will not cause galvanic action at contact points. Use mountings that correctly position luminaire to provide indicated light distribution.
- E. Pole Bases: Anchor type with galvanized steel hold-down or anchor bolts, leveling nuts and bolt covers. Provide with bolt cover.
- F. Poles: Steel tubing conforming to ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psi (317 MPa). Poles are one-piece construction up to 40 feet (12 m) in length and have access handhole in wall.
- G. Metal Pole Grounding Provisions: Welded 1/2-inch (12-mm) threaded lug, accessible through handhole.
- H. Metal Pole Brackets: Designed to match pole metal. Provide cantilever brackets without underbrace, in sizes and styles indicated, with straight tubular end section to accommodate fixtures.
- I. Pole-Top Tenons: Fabricated to support fixture or fixtures and brackets indicated and securely fastened to pole top.
- J. Concrete for Pole Foundations: Comply with Division 3 Section "Cast-in-Place Concrete." Use 3000-psi (20.7-MPa) strength, 28-day concrete.
- K. Provide additional device and tapped holes as required for wiring devices, cameras and other equipment as called for on the project plans. Coordinate locations with applicable trades.

2.4 FINISHES

- A. Metal Parts: Manufacturer's standard finish, except as otherwise indicated, applied over corrosion-resistant primer, free of streaks, runs, holidays, stains, blisters and similar defects.
- B. Other Parts: Manufacturer's standard finish, except as otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set units plumb, square, level and secure according to manufacturer's written instructions and approved Shop Drawings.
- B. Provide necessary accessories required for the support or mounting of fixtures. Where necessary, provide bridging between structural members.
- C. Concrete Foundations: Construct according to Division 3 Section "Cast-in-Place Concrete."
 - 1. Comply with details and manufacturer's recommendations for reinforcing, anchor bolts, nuts and washers. Verify anchor-bolt templates by comparing with actual pole bases furnished.
 - 2. Finish: Trowel and rub smooth parts exposed to view.
- D. Pole Installation: Use web fabric slings (not chain or cable) to unload, store, raise and set poles.
- E. Fixture Attachment: Fasten to indicated structural supports.
- F. Fixture Attachment with Adjustable Features or Aiming: Attach fixtures and supports to allow aiming for indicated light distribution.
- G. Install wiring, wiring devices, cameras and appurtenances as required or indicated on project plans.

3.2 GROUNDING

- A. Ground fixtures and metal poles according to Division 26 Section "Grounding System."
 - 1. Poles: Install 10-foot (3-m) 3/4" diameter driven ground rod at each pole and connect ground rod to pole-mounted ground lug with #6 AWG solid bare conductor.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed unit for damage. Replace damaged fixtures and components.
- B. Tests and Observations: Verify normal operation of lighting units after installing fixtures and energizing circuits with normal power source. Include the following:
 - 1. Check for intensity of illumination.
 - 2. Check for uniformity of illumination.
 - 3. Check for excessively noisy drivers.
 - 4. Adjust lamps and reflectors as required.
- C. Replace or repair damaged and malfunctioning units, make necessary adjustments and retest. Repeat procedure until all units operate properly.

3.4 ADJUSTING AND CLEANING

- A. Clean units after installation. Use methods and materials recommended by manufacturer.

B. Adjust amiable fixtures to provide required light intensities.

END OF SECTION 260525

SECTION 260721 – FIRE ALARM SYSTEMS - ADDRESSABLE

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes addressable fire alarm systems.

1.2 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.
- B. Section 260000 Basic Electrical Requirements
- C. Section 260010 Basic Electrical Materials and Methods

1.3 QUALITY ASSURANCE

- A. The equipment and installation shall comply with the current applicable provisions of the following standards:
 - 1. National Electrical Code, NFPA 70
 - 2. National Fire Alarm Code, NFPA 72
 - 3. International Building Code, IBC
 - 4. Life Safety Code, NFPA 101
 - 5. UL 864, 9th Edition Listed and Factory Mutual Approved
 - 6. ADA and ANSI A117.1
 - 7. NECA 305, "Standard for Fire Alarm System Job Practices."
 - 8. Applicable Local and State Building codes
 - 9. Requirements of the Local Authority Having Jurisdiction
- B. Equipment Supplier Qualifications
 - 1. The fire alarm equipment supplier shall have a NICET level 4 certified individual on staff responsible for overseeing the technical design and engineering functions related to the fire alarm system. The current NICET level 4 certificate number must be submitted to the engineer with shop drawings submittals.
 - 2. The fire alarm equipment supplier shall have on staff NICET level 2 technicians supervising the final connections and programming of the system.
 - 3. The equipment supplier must be an authorized distributor/dealer of the equipment being provided. The supplier must be factory authorized to service under warranty the components furnished. Two stepping of equipment from a "box house" or out of area distributor is not allowed.
 - 4. Fire Alarm Contractor shall be capable of providing signed and sealed shop drawings for the fire alarm system, by a Professional Engineer of the State in which the project is located.

1.4 SUBMITTALS

- A. Shop Drawings
 - 1. The Contractor shall provide complete fire alarm system documents signed and sealed documents by a Professional Engineer of the State in which the project is located as follows:
 - a. Battery calculations
 - b. Voltage drop calculations
 - c. Wiring details and diagrams including types and sizes

- d. Location of FACP, power supplies, DACT, annunciators, power connections, etc
 - e. Floor plan indicating use of each room, ceiling heights and construction
 - f. Fire alarm matrix and interface of the fire safety controls functions
 - g. Equipment, device and material cutsheets and technical details including but not limited to the model number, listing info, type, rating, size, style, for all items.
 - h. Complete list of deviations, exceptions and variations from the Contract Documents related to the fire alarm system and associated equipment and systems.
2. The fire alarm shop drawings will be returned incomplete if signed and sealed documents as outlined above are not submitted. Engineer will provide a preliminary shop drawing review for general conformance prior to submitting final signed and sealed drawings upon request.
 3. In the event a separate fire alarm permit/review is required, the signed and sealed Contractor shop drawings are to be submitted to SSC Engineering for review prior to SSC Engineering providing any signed and sealed fire alarm Contract Documents.
 4. It is the responsibility of the Contractor to provide the above information in a timely fashion to accommodate the construction schedule.
 5. Provide proof of authorization from equipment manufacturer for being a dealer and NICET certificates. The current NICET level 4 certificate number must be submitted to the engineer with shop drawings submittals. Shop drawing will be rejected if a current NICET certificate is not submitted.
 6. Provide proof of authorization from equipment manufacturer for being a true authorized distributor/dealer for service and warranty as well as NICET certificates.
- B. Record Drawings
1. Provide one complete set of as-built record drawings following project completion. The drawings shall include:
 - a. Routing of conduit and all wiring from each device, i.e. smoke detector, signaling appliance, etc. to the control panel, or remote power supply.
 - b. Clearly identify each indicating appliance circuit, initiating or SLC circuit, control circuit, etc. and quantity of conductors.
 - c. Device location and identification number, control panel, circuit breaker and end-of-line resistor locations.
 2. Provide one complete set of Operations and Maintenance Manuals, including completed Initial Acceptance Test form, Record of Completion form, and final submittal documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The FACP shall be a Notifier NFS-320 or approved equal and shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, annunciators and other system controlled devices. The panel shall be UL listed as a Fire Alarm Control Panel per UL 864, 9th Edition.
- B. Equal systems by Fire Warden, Edwards, Simplex, Siemens, or Gamewell-FCI shall be considered approved equals provided the systems meet all performance requirements of these specifications.

2.2 SYSTEM GENERAL OPERATION

A. System Alarm Detection

1. When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:
 - a. The System Alarm LED shall flash.
 - b. A local signal in the control panel shall sound.
 - c. The 80-character LCD display shall indicate all information associated with the Fire Alarm condition, including: type of alarm point, its location within the protected premises and the time and date of that activation.
 - d. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed including:
 - 1) Alarm Indicating appliances.
 - 2) Control relays for general air handler shutdown.
 - 3) Control relays to recall and shut down power to the elevators per ASME A17.1 requirements.
 - 4) Central station outputs for connection digital communicator:
 - a) Alarm
 - b) Trouble
 - c) Supervisory
2. The Microprocessor unit shall contain and execute all control by event programs for specific action to be taken if an alarm condition is detected by the system. Such control by event programs shall be held in nonvolatile programmable memory and shall not be lost even if system primary and secondary power failure occurs.
3. All programming of the system may be achieved without special equipment or lap top computers and without interrupting the alarm monitoring functions of the Fire Alarm Control Panel. If special hardware or software is required to program the system it must be included in this contract and be provided to the owner at time of delivery and the owner must be trained on the programming of the system.
4. Program edit shall not interfere with normal operation and fire protection. If a fire condition is detected during programming operation, the system shall exit programming and perform fire protection functions as programmed.
5. Provide a battery back-up and charging system for 24 hours of standby and 5 minutes of alarm for the entire fire alarm system.

B. Special FACP Features

1. The FACP shall provide the following features:
 - a. Drift Compensation to extend detector accuracy over life.
 - b. Sensitivity Test, meeting requirements of NFPA 72.
 - c. Maintenance Alert to warn of excessive compensation.
 - d. System Status Reports to display or printer.
 - e. Alarm Verification, with verification counters.
 - f. Non-Alarm points for general (non-fire) control.
 - g. Periodic Detector Test, conducted automatically by software.
 - h. Walk Test, with check for two detectors set to same address.
 - i. Control by Time for non-fire operations, with holidays.
 - j. Day/Night automatic adjustment of detector sensitivity.

C. Control Panel Switches

1. Acknowledge Switch

- a. Activation of the control panel Acknowledge switch in response to new Alarms and/or Troubles shall silence the local panel piezo electric signal and change the Alarm and Trouble LEDs from flashing mode to steady ON mode. If multiple Alarm or Trouble conditions exist, depression of this switch shall advance the 80 character LCD display to the next Alarm or Trouble condition. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.
- 2. Signal Silence Switch
 - a. Activation of the Signal Silence Switch shall cause all programmed Alarm Indicating Appliances and relays to return to the normal condition after an alarm condition. The selection of indicating circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.
 - 3. System Reset Switch
 - a. Activation of the System Reset Switch shall cause all electronically latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition. Holding the RESET switch shall perform a Lamp Test function.
 - 4. Drill (Evacuate) Switch
 - a. Press and hold of the Drill switch shall activate all Indicating Appliance circuits. The Drill function shall latch until press of Signal Silence or Reset.
- D. SLC Loop Interface
- 1. The SLC Interface shall provide power to, and communicate with, all of the Intelligent/Addressable Detectors and Addressable Modules over a single pair of wires.
 - 2. The Loop Interface Board shall receive analog information from all Intelligent Detectors that shall be processed to determine whether normal, alarm or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.
 - 3. The detector software shall meet NFPA 72 requirements and be certified by UL as a calibrated sensitivity test instrument.
 - 4. Provide dedicated loops as required to accommodate design requirements.
- E. System History Recording and Reporting
- 1. The Fire Alarm Control Panel shall contain a History Buffer that will be capable of storing up to 400 system alarms/troubles/operator actions. Each of these activation's will be stored and time and date stamped with the actual time of the activation. The contents of the History Buffer may be manually reviewed, one event at a time.
 - 2. The History Buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable.
- F. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel which shall include a backlit 80 character Liquid Crystal Display, individual, color coded system status LEDs and an alpha-numeric keypad for the Field Programming and Control of the Fire Alarm System.

- G. The remote fire alarm annunciator shall include a full featured operator interface control and annunciator panel which shall include a backlit 80-character liquid crystal display; individual color coded system status LEDs and an alpha-numeric keypad for the field programming and control of the fire alarm system. Notifier model LCD 80.
- H. Maintenance Functions
 - 1. Smoke Detector Sensitivity Adjust
 - a. Means shall be provided for adjusting the sensitivity of any or all analog intelligent detectors in the system from the System keypad. Sensitivity range be will be within the allowed UL window and shall be HIGH/MEDIUM/LOW selection.
 - 2. Alarm Verification
 - a. Each of the Intelligent/Addressable Smoke Detectors in the system shall be alarm verified. The Alarm Verification Function shall be from 5-50 seconds and each detector shall be able to be enabled/disabled during the field programming of the system, or any time after system turn-on.
 - 3. Automatic Detector Maintenance Alert
 - a. The Fire Alarm Control Panel shall automatically interrogate each Intelligent Smoke Detector and shall analyze the detector responses over a period of time. If any Intelligent Smoke Detector in the system responds with a reading that is below or above normal limits, then the system will enter the Trouble Mode and the particular Detector will be annunciated on the System Display. This feature shall in no way inhibit the receipt of Alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

2.3 FIELD DEVICES

- A. Addressable Manual Stations
 - 1. Addressable Manual Stations shall be provided to connect one addressable, supervised Manual Station to one of the Fire Alarm Control Panel Signaling Line Circuit (SLC) Loops. The Manual Station shall, on command from the Control Panel, send data to the panel representing the state of the manual switch. Manual Fire Alarm Stations shall be crush tube type with a key operated test-reset lock. Notifier model NBG-12LX.
- B. Automatic Fire Detectors
 - 1. Analog Addressable Photoelectric Type Smoke Detectors
 - a. The Photoelectric-Type Smoke Detectors shall be Intelligent and Addressable and shall connect with two wires to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. The detectors shall use the light obscuration principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.
 - b. The detectors shall be ceiling-mount and shall include a twist-lock base. The detectors shall provide address-setting means on the detector head using rotary decimal switch and shall also store an internal identifying code which the control panel shall use to identify the type of detector. An output connection shall also be provided in the base to connect an external remote alarm LED. The detector sensitivity shall be set through the Fire Alarm Control Panel and shall be adjustable in the field through the field programming of the system. Notifier model FSP-851 with B210LP standard base.
 - 2. Analog Addressable Duct Smoke Detectors

- a. Duct Smoke Detectors shall be addressable and analog photoelectric type devices enclosed in a duct type housing and supplied with sampling tubes sized for the duct. The detectors shall be Intelligent and Addressable and shall connect with two wires to the Fire Alarm Control Panel Signaling Line Circuit. The detector sensitivity shall be set through the Fire Alarm Control Panel and shall be adjustable in the field through the field programming of the system. Notifier model DNR with FSP-851, DST-XX sampling tubes, and RTS151KEY remote test switch station with key lock.
 - 3. Analog Addressable Heat Detectors
 - a. The Intelligent Heat Detectors shall be Intelligent and Addressable and shall connect with two wires to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. The detectors shall use an electronic sensor to measure thermal conditions caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements.
 - b. The detectors shall be ceiling-mount and shall include a twist-lock base. The detectors shall provide address-setting means on the detector head using rotary decimal switch and shall also store an internal identifying code, which the control panel shall use to identify the type of detector. Notifier FST-851, 135 degree fixed thermal detector or FST-851H, 190 degree fixed thermal detector with B210LP standard base.
- C. Remote Fire Alarm Annunciator Panel (FAAP):
 - 1. The remote fire alarm annunciator shall include a full featured operator interface control and annunciator panel which shall include a backlit 80-character liquid crystal display; individual color coded system status LEDs and an alpha-numeric keypad for the field programming and control of the fire alarm system. Notifier model LCD 80.
- D. Control Module
 - 1. Control Modules shall be provided to supervise and control the operation of one signal circuit or as an addressable Dry Contact (Form C) Relay for elevator and air handler control. The Control Module shall provide address-setting means using rotary decimal switches and shall also store an internal identifying code which the Control Panel shall use to identify the type of device. Notifier model FCM-1 or FRM-1
- E. Monitor Module
 - 1. Monitor modules shall be provided to connect any N.O. dry contact device (water flow, tamper switches and kitchen hood) to the Fire Alarm Control Panel Signaling Line Circuit Loop. The Monitor module shall provide address-setting means using rotary decimal switches and shall also store an internal identifying code which the Fire Alarm Control Panel shall use to identify the type of device. Notifier model FMM-1, FMM-101 or FDM-1 (Dual).
- F. Horn Strobes
 - 1. Audible signals shall be all-electronic and shall not require vibrating solenoids or contacts. They shall be 24 VDC polarized and meet UL 1971. Mounting shall be semi-flush using standard back boxes. The visual section shall be 24 VDC polarized Xenon strobe with FIRE lettering clearly visible. The horn shall include a high/low switch to provide 100 dBA (high) or 94 dBA (low) sound pressure based on anechoic chamber measurements. Set on low volume setting in small rooms, stairwells and restrooms. The horn output shall be switch selectable between a continuous tone or Temporal Code 3 tone. Set tone to Temporal Code 3 pattern. Provide signals based on the following types:

- a. Horn/ strobe with multi-candela output: Wheelock HSR (use HSW if white is acceptable to AHJ.) Add suffix 'C' for ceiling mount.
 - b. Strobe light with multi-candela output: Wheelock STR (use STW if white is acceptable to AHJ.) Add suffix 'C' for ceiling mount.
 - c. Horn: Wheelock HNR (use HNW if white is acceptable to AHJ.) Add suffix 'C' for ceiling mount.
2. Provide weatherproof appliance and back box when installed exterior to the building, within wet locations or wherever located outside the listed environment of the "standard" notification appliance.
- G. Magnetic Door Holders
- 1. Magnetic door holders shall be 120 VAC and 24 VAC/DC models with 35 to 40 pounds holding power. Magnet protected against transients and surges up to 600 volts (AC models). Magnetic field intensity of 5.6 oersteds and 1 meter. Fail-safe operation; power failure releases door to close. Floor and wall models and two year warranty. Holder shall be Notifier FM980 for floor mounting or FM998 for flush wall mounting or equivalent by Sentrol.
- H. Remote Power Supplies
- 1. Signaling appliance remote power supplies shall be UL listed for fire alarm signaling and provide 6 amps of 24 VDC power. The power supply shall include 4 style Y notification appliance circuits. Provide two 7.0 amp hour batteries with each power supply. Remote power supply shall be Notifier model FCPS-24S6. Provide as required for audible/visual signals.
- I. Central Monitoring Equipment shall be UL listed and include a commercial fire digital communicator complete with the following features:
- 1. Meet NFPA 72 requirements for Digital Alarm Communicator Transmitter.
 - 2. Capable of seizing the proper communication method at the protected premises, disconnecting an outgoing or incoming call and preventing its use until signal transmission has been completed.
 - 3. Contain a minimum of 4 channels.
 - 4. Connected to two separate communication methods at protected premises.
 - 5. Capable of selecting the operable communication method in the event of a failure on either method.
 - 6. Programmed to utilize the alternate method should the signal transmission be unsuccessful.
 - 7. Equipped with battery pack, charger, telephone jack and dedicated 120 VAC receptacle.
 - 8. The digital communicator shall be connected to the fire alarm system to receive and transmit alarm signals, trouble conditions and supervisory conditions. Digital Communicator shall be Notifier model 411UDAC. Monitoring service and communicator programming shall be furnished by owners monitoring company.
 - 9. Provide a dual path communicator module/device that utilizes IP communication and cellular (GSM or CDMA) communication. Provide programming, cables and connectors as required. Owner to provide active data port.

PART 3 - EXECUTION

3.1 POWER SOURCE

- A. The Fire Alarm Control Panel shall be connected to a separate dedicated 120 volt, 20 Amp branch circuit. This circuit shall be labeled at the Electrical Panel as FIRE ALARM.

- B. The fire alarm remote power supplies shall be connected to a dedicated 120 volt, 20 amp branch circuit labeled as FIRE ALARM. Provide required quantities of power supplies and circuits as required.

3.2 WIRING

- A. Wiring will be as required by the Equipment Supplier. Wire color coding and the color shall remain the same throughout the system. In general, all initiating devices such as manual stations, thermal detectors and smoke detectors shall be installed across a common #18 AWG twisted shielded pair. The signal circuits shall require #14 AWG. All system wiring shall be plenum rated wire. The ground will be minimum one #6 AWG insulated copper. Provide conduit with insulated bushing in wall from device up to accessible ceiling.

3.3 TESTING

- A. The operation of the Fire Alarm System shall be checked by a representative of the equipment supplier. At the final inspection, a factory-trained representative of the manufacturer of the equipment shall demonstrate that the system functions properly in every respect. A report describing the test results shall be submitted to the Engineer.
- B. The system will not be accepted until final testing and receipt of the NFPA 72 Inspection and Testing Form has been obtained and approved.
- C. System shall be tested and installed to maintain the UL "UUFX" listing as required by the AHJ, Fire Protection District or Fire Department.

3.4 INSTRUCTION

- A. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system including changes and functions shall be provided.
- B. The contractor and/or the systems manufacture's representatives shall provide a type written "sequence of operation" to allow the owner to silence reset and acknowledge the fire alarm control panel.
- C. Provide a minimum of eight (8) hours training for staff personnel in the operation and maintenance of the system.

3.5 INSTALLATION

- A. In order to assure compliance with the NFPA Standards and manufacturers requirements the fire alarm equipment supplier to the electrical contractor must perform the following functions:
 1. Install and connect each and every detector, signaling appliance, pull station, control/monitor module, annunciator etc., excluding the rough-in and cabling between the devices.
 2. The electrical contractor shall install rough-in and cable between rough-in points as required by the fire alarm system supplier. Rough-in includes control panel back boxes, remote power supply back boxes and digital communicator back boxes.
 3. The electrical contractor shall provide any conduit, all required back boxes, 120 volt power and connections of the 120 volt power as required by the fire alarm equipment supplier to meet the functionality specified herein.
 4. Subcontracting by the fire alarm equipment provider to perform the field device installation and connections is not acceptable.
 5. Open conductors and conduits shall be supported in a manner and at intervals compliant with NEC requirements. Conductors and conduits installed above lay-in ceilings shall be

supported from the building structure and shall not be permitted less than 9-inches above or behind removable panels or ceiling tiles.

6. All wires shall be tagged at all junction points and shall test free from grounds or crosses between conductors.
7. No other conductors shall be installed in conduits with conductors for the fire alarm system.
8. Smoke detectors shall be protected from construction dust until after the construction clean-up of all trades is complete and final. Detectors that have not been protected prior to final clean-up by all trades shall be cleaned or replaced.
9. A UL Certificate or FM Placard, per NFPA 72, shall be issued by the UL Listed or FM Approved contractor for all newly installed, required fire alarm systems.

B. Equipment Mounting

1. The control panel shall be flush mounted with no operational parts which may require maintenance mounted greater than 72-inches above the finished floor. The control panel annunciator shall be mounted so that no switch, manually operated device, display or LED is greater than 60-inches above the finished floor.
2. Duct detectors shall be provided under this section and will be mounted by the HVAC contractor at the supply side of all HVAC units of 2,000 cfm or greater and at the return side of all HVAC units of 2,000 cfm or greater per NFPA 90A and IMC, or as shown on the drawings. Supervise and coordinate placement by HVAC contractor and connect all circuits. Duct detectors shall be mounted in such a way as to obtain a representative sample of the airstream. The duct detectors shall be located in the zone between 6 and 10 duct widths from any duct bends or inlets. When located at duct openings, use spot detectors mounted as required by NFPA 72 for duct openings. Detectors shall be accessible for cleaning and shall be mounted in accordance with the manufacturer's instructions and NFPA standards.
3. At each smoke or fire smoke damper provide a spot detector pendant mounted in the duct with an access panel for maintenance and testing.
4. All HVAC equipment shutdown and smoke control functions shall be initiated by addressable control module interface with the EMS system. Relays shall be mounted within three (3) feet of the EMS interface equipment.
5. The remote annunciator shall be mounted so that no switch, manually operated device, display, or LED is greater than 60-inches above the finished floor.
6. The manual pull station(s) shall be securely mounted with the operable part of the manual pull station at 46-inches above the finished floor.
7. Wall mounted audible/visual, audible and/or visual devices shall be mounted with their bottoms at 80-inches above the finished floor or 6-inches below the ceiling, whichever is lower.
8. Ceiling mounted audible/visual, audible and/or visual devices shall be mounted where shown on the drawings with their visual lenses having an unobstructed line of site in all directions. Exact locations of devices shall be sufficiently distant from vertical surfaces and hanging items to permit maximum viewing from all directions.
9. Weatherproof audible/visual notification device shall be mounted at the fire department connection on the building exterior and with the final location as acceptable to the AHJ.

10. Devices shall not be supported by ceiling tiles. Devices must be attached to a back-box supported by the ceiling grid.
11. At each door (man, overhead, counter, etc.) with magnetic hold opens, provide smoke detector(s) located in accordance with NFPA 72, whether shown on plans or not.

C. Painting and Patching

1. All fire alarm conduit shall be thoroughly cleaned, removing all dirt, oil, etc. and made ready to receive paint.
2. Holes in walls or floors cut during the performance of this work shall be patched or covered with standard escutcheon plates so as to completely conceal the cuts where they would otherwise be exposed to view.
3. Firestop all penetrations of fire rated assemblies.

END OF SECTION 260721

SECTION 260724 – TELEVISION SYSTEM ROUGH-IN

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This specification is for the rough in of the following television systems.
 - 1. Video Surveillance System
 - 2. Cable TV System
 - B. Extent of television (TV) systems work is indicated by drawings.
 - C. This contract requires the furnishing and installation of conduit, boxes, cable, cable terminal cabinet, and the providing of a 120 volt power circuit for the terminal cabinet.
- 1.2 All cameras, video monitors, digital video recorders, mounting arms, domes, etc. shall be provided under a separate contract by the owner's video surveillance vendor.
- 1.3 The final patching from the wall jack to the cable TV will be furnished and installed by the Owner.

PART 2 - PRODUCTS

- 2.1 Provide conduit and boxes, as specified in Section 260110.
- 2.2 Cable TV cable shall be RG6/U quad shield coaxial cable; 75-ohm characteristic impedance; with copper inner conductor; outer conductor braided aluminum wire; cellular polyethylene low density dielectric core; with black vinyl jacket; and 100 percent sweep tested. Cable shall be plenum rated unless installed in conduit.
- 2.3 Video surveillance cable shall be Cat 6.

PART 3 - EXECUTION

- 3.1 Provide raceways and boxes as shown on the drawings. This shall include two-gang boxes with single-gang raised cover and 1 inch empty conduit with insulated bushing roughed into an accessible ceiling.
- 3.2 Pull cable(s) from main terminal board or enclosure and terminate at wall jacks.
- 3.3 All empty conduits shall be provided with a pull wire.

END OF SECTION 260724

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SECTION 260760 – DATA AND COMBINATION DATA TELEPHONE ROUGH-IN SYSTEM

PART 1 - GENERAL

- 1.1 This section covers complete rough-in for the data system.
- 1.2 The data wiring will be furnished and installed by the Owner.

PART 2 - PRODUCTS

- 2.1 Provide conduit and boxes, as specified in Section 260110.

PART 3 - EXECUTION

- 3.1 This subcontractor shall provide raceways and boxes as shown on the drawings. This shall include two-gang boxes with single-gang raised cover and 1 inch empty conduit with insulated bushing roughed into an accessible ceiling. This shall include data conduit and combination data and telephone conduit.
- 3.2 All empty conduits shall be provided with a pull wire.

END OF SECTION 260760

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SECTION 260770 – SECURITY SYSTEM ROUGH-IN

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers complete rough-in for burglar alarm and access control security equipment.
- B. The security equipment shall be provided by the owner's security system supplier.
- C. Devices shown on drawings are for reference only. Exact number of devices, types and locations are determined from security contractor's shop drawings. Provide complete conduit system.
- D. System wires shall be furnished and installed by the security equipment supplier.

PART 2 - PRODUCTS

- 2.1 Provide conduit and boxes, as specified in Section 260110 or as shown on drawings.

PART 3 - EXECUTION

- 3.1 Provide raceways and boxes as shown on the drawings. This shall include two-gang boxes with single-gang raised cover and 1 inch empty conduit with insulated bushing roughed into an accessible ceiling.
- 3.2 All empty conduits shall be provided with a pull wire and insulated bushing.
- 3.3 Refer to rough-in details on project plans for access control and security rough-in boxes and conduits.

END OF SECTION 260770

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SECTION 260934 - NETWORKED LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wireless Network Lighting Controls – 26 09 43.19

1.2 REFERENCES

A. National Fire Protection Association (NFPA)

B. cULus Listing/Certification

1. Certified as Energy Management Equipment (UL 916)
2. Certified as Emergency Lighting Equipment (UL 924)
3. Meet Heat and Smoke Release for Air-Handling Spaces (UL 2043)

C. CSA Listing/Certification

1. Emergency lighting equipment (CSA C22.2 NO. 141-15)
2. Signal equipment (CSA C22.2 No. 205)

D. Federal Communications Commission (FCC) / Industry Canada (IC)

E. California Energy Commission (CEC)

F. Local Building Codes

1.3 SYSTEM DESCRIPTION

A. Lighting Control System includes computer-based software that provides control, configuration, monitoring and reports. System includes the following components:

1. Wireless Manager
2. System Server
3. 0-10V Dimming, Fixed Output Ballasts or 0-10V LED Drivers
4. Wireless Control Modules
5. Connected Lighting Modules – Provide integral Wireless Control for luminaires
6. Wireless Sensors (Occupancy/Photo)
7. Low-Voltage Sensors (PIR, Dual-Technology, Photo)
8. Wallstations – Wireless/Low-Voltage
9. Lighting Control System Software - Graphical User Interface based
10. LCD Touch Screen Panel
11. Communication Wire
12. Wireless Area Lighting Controllers (to dim/switch a group of luminaires)
13. AC Phase Cut Dimming Module (Forward & Reverse)
14. Relay based Lighting Control Panels
15. Interface to Audio Visual equipment (for integration with 3rd party LCD Touch Screen Panel)
16. Interface to BACnet
17. Interface to Tridium Niagara
18. Interface to customizable Energy dashboard

1.4 SUBMITTALS

A. General: Provide submittals per 1.4 (B – J) below:

- B. Bill of Materials: Complete list of all parts needed to fully install selected system components.
- C. Product Data: For each type of product indicated.
- D. Shop and Wiring Drawings: Submit shop drawings detailing control system, as supplied, including one-line diagrams, wire counts, coverage patterns, interconnection diagrams showing field-installed wiring and physical dimensions of each item.
- E. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - 1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
- F. Software Operational Documentation:
 - 1. Software operating and upgrade manuals
 - 2. Program Software Backup: On portable memory storage device, compact disc, or DVD, complete with data files.
 - 3. Printout of software application and graphic screens, or upon request, a live demonstration of Control, Configure and Analyze functionality or a video demonstrating above stated system capabilities.
- G. Installation Instructions: Manufacturer's installation instructions.
- H. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
- I. Warranty: Copy of applicable warranty.
- J. Additional information as required on a project specific basis.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Installer shall be one who is experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.
- B. Manufacturer Requirements: The manufacturer shall have a minimum of 15 years' experience manufacturing networked lighting control systems and shall provide 24/7 telephone support by qualified technicians.
- C. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and system controllers shall be resolved between the contractor and the system provider, as required to ensure proper system operation and maintainability.
- D. Performance Requirements: Shall provide all system components that have been manufactured, assembled, and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.
- E. Performance Testing Requirements
 - 1. Manufacturer shall 100% test all equipment prior to shipment. Sample testing is not acceptable.
- F. Code Requirements

1. System Control Unit and System Field Devices shall be cULus listed and certified.
2. All system components shall be FCC /IC compliant.
3. All system components shall be installed in compliance with National Electrical Codes and Canadian Electrical Code.
4. Building Codes: All units shall be installed in compliance with applicable, local building codes.

G. ISO Certification: System components shall be manufactured at ISO-9000 certified plants.

H. Coordination

1. Shall coordinate lighting control components to form an integrated interconnection of compatible components.
 - a. Match components and interconnections for optimum performance of lighting control functions.
 - b. Display graphics showing building areas controlled; include the status of lighting controls in each area.

1.6 PROJECT CONDITIONS

1. Operating Temperature Range: -40 deg F (-40 deg C) to 140 deg F (+60 deg C) 'applicable devices'
2. Humidity
 - a. Wired field devices: 0% to 100% RH condensing rated for damp locations and 0% to 95% RH non-condensing rated for indoor locations.
 - b. Wireless modules: 5% to 95% RH non-condensing rated for indoor locations.

1.7 DELIVERY, STORAGE & HANDLING

- A. Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
- B. Delivery: Deliver materials in manufacturer's original, unopened, undamaged packaging with intact identification labels.
- C. Storage and Protection: Store materials away from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.8 WARRANTY

- A. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements shall be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.
- C. Manufacturer's Warranty: All equipment shall be warranted free of defects in materials and workmanship.
 1. Warranty Period: All system hardware components, excluding third party components, shall have full warranty (non-prorated) for a period of sixty (60) months and all software, excluding Open Source Software and third party operating systems, perform substantially in accordance with published specifications for a period of twelve (12) months from the date of System Start-up.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Controls: ENCELIUM[®] Energy Management System by OSRAM SYLVANIA
- B. Sensors: ENCELIUM Sensors by OSRAM SYLVANIA, Leviton Mfg. Co., Hubbell Building Automation, Inc., SensorSwitch, Inc., PLC Multipoint Inc., The Watt Stopper, Inc. Cooper Controls or equivalent.
- C. 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers: OSRAM Sylvania, Inc., Tridonic, Universal Lighting Technologies, Philips Lighting or equivalent.

2.2 SYSTEM PERFORMANCE REQUIREMENTS

This specification is intended to fully describe all of the design, engineering, programming, hardware, software, ancillary devices and associated technical services required to provide a building-wide networked lighting control system. This system is specified to perform scheduled and automated lighting control sequences.

- A. The lighting control "system" shall include a fully distributed WAN/LAN network of global controller/routers, individually addressable System Field Devices that are not integral to luminaires, sensors, switches, relays and other ancillary devices required for a complete and operable system. The system WAN/LAN start-up shall be by the control system manufacturer or contractors certified by the manufacturer.
- B. The basis of system design shall utilize non-proprietary industry standard 0-10V dimming or fixed output ballasts and/or 0-10V LED drivers, occupancy sensors, daylight sensors, etc.
- C. UL 924 listed devices shall have the ability to control 120V/277V/347V load.
- D. System software interface shall have the ability to notify communication failures to system users via system & email messages. Email messages shall be available in html and text formats.
- E. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements may be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.
- F. Lighting Control Software: The system shall offer two separate levels of lighting control: (1) personal lighting control for the average building occupant to control and adjust basic lighting functions in their workspace, and (2) central lighting control for the facility lighting administrator to perform energy management, configuration maintenance, monitoring operations, and providing support to building occupants.
 - 1. Native central control software shall be utilized for energy performance monitoring and complete programming without the need for any third party hardware or software. Systems that require any third party linked software or graphics shall be unacceptable.
 - 2. Software shall provide information on general system settings via mouse click on a floor plan. Left clicking over a device on the graphical software interface shall show a description of the selected device/function attribute.
 - 3. Central Lighting Control:
 - a. Shall provide an Interactive, Web-based graphical user interface (GUI) showing floor plans and lighting layouts that are native to the lighting control software. The only means required to program and operate the lighting control system shall be programmed and operated from a user interface that is based on a plan view graphical screen on the user's computer or the lighting control system's main computer. Shall include the navigational features listed below to allow for user's orientation within the controlled space, geographic heading and/or landmarks:

- 1) Interactive;
 - 2) Vector based;
 - 3) Zoom;
 - 4) Rotate;
 - 5) Pan;
 - 6) Tilt.
- b. Shall allow building operator to navigate through an entire facility both in two-dimensional and three-dimensional multi-floor view, allowing for fast and easy navigation.
 - c. Three-dimensional view shall exclude walls and other structural features to avoid shadowing and cluttering of the plan view.
 - d. Shall display multiple floors in single view resulting in easier system performance visualization for the entire site as well as individual zones or spaces.
 - e. Shall allow system performance visualization across a portfolio of buildings via a single interface.
 - f. All programming, assignments of lighting loads to control strategies, lighting status and lighting energy reporting shall be native to the software and executed from this GUI. Editing shall be available from this GUI in a drag and drop format or from drop down menus without the need for any third party software. Systems that utilize or require third party linked graphics are unacceptable. The GUI shall continuously indicate the status of each connected device on the system and a warning indicator on the software if a device goes offline. Systems requiring spreadsheet editing for programming and that don't offer real time feedback are not acceptable.
 - g. Software settings and properties shall be selectable per individual device, room based, floor based or global building based.
 1. Lighting Control Software interface shall provide current status and enable configuration of all system zones including selected individual luminaire availability, current light level, maximum light level, on/off status, occupancy status, and emergency mode (response to an emergency signal) status.
 - h. Shall have the ability to display various lighting system parameters such as Lighting status (ON/OFF); Lighting levels, Load shedding status, or Lighting energy consumption, Occupancy status in a colorized gradient ("weather" map) type of graphical representation.
 - i. Energy Analysis data shall be exportable in CSV or image file formats.
 - j. Shall allow import of native AutoCAD files.
4. Reports: Reporting feature shall be native to the lighting control software and capable of reporting the following parameters for each device and zone individually without requiring any third party hardware and software:
 - a. Energy consumption broken down by energy management strategy.
 - b. Energy demand broken down by energy management strategy.
 - c. Occupancy data by zone.
 - d. Building wide occupancy status
 - e. Time Schedule status
 - f. Lighting energy consumption in a color gradient ("weather map" type) view
 - g. Energy performance reports shall be printable in a printer friendly format and downloadable for use in spreadsheet applications, etc.

- h. Battery status report indicating device name, location on the floor plan and battery voltage shall be printable in a printer friendly format and downloadable for use in spreadsheet applications, etc.
 - i. Color gradient (“weather map” type) view for the following:
 - 1) Robustness of the mesh network (hop count)
 - 2) Route of the signal
 - 3) Wireless signal strength
 - 4) Battery status for wireless components
5. Personal Lighting Control: The Personal Control Software interface shall provide current status and enable each user with the ability to dim and brighten lights, and turn them on and off by individual luminaire or zone. The Software shall offer user configurable light scenes, which may be programmed and then selected via the Software. Personal lighting control shall be available in open/private office environments. This software shall have the capability of acting as a “virtual occupancy sensor” for the system by detecting keyboard or mouse activity on each PC for incremental occupancy status data.
- a. Fade Time: The software shall offer user configurable fade times (up to 86400 seconds) for individual or group of luminaire during transition between scenes.
- G. Daylight Harvesting (Light Regulation Averaging): In a photo sensor-equipped system, the Central Controller Unit shall rationalize changes to light levels when ambient (natural) light is available and shall maintain a steady light level when subjected to fluctuating ambient conditions where 0-10V dimming-ballasts and/or drivers exist. Areas equipped with fixed output ballasts and/or drivers shall energize when natural light falls below foot-candle levels specified. System shall utilize light level inputs from common and/or remote sensor locations to minimize the number of photo sensors required. The System shall operate with multiple users in harmony and not react adversely to manual override inputs.
- H. Time Clock Scheduling: The system shall be programmable for scheduling lights on or off via the Lighting Control Software interface.
- 1. Programming: User friendly, Outlook style interface shall be available for programming schedules.
 - 2. Override: Manual adjustments via wallstations or personal control software shall temporarily override off status imposed by time clock schedule.
 - 3. Response to Power Failure: In the event of a power failure, the time clock shall execute schedules that would still be in progress had they begun during the power outage.
 - 4. Flick Warning: Prior to a scheduled lights-off event or expiry of a temporary override, the system shall provide two short light level drops as a warning to the affected occupants. Flick warning time shall have the ability to be programmed via software between 1 and 5 minutes.
 - 5. Option to automatically turn on or wait for an input: Using this option, a group of luminaires can be made to turn on automatically in response to a scheduled event or wait for a signal from a wallstation to turn the same group of luminaires on (and stay on) for the remainder of the scheduled event.
 - 6. Shall support BMS Schedules/Calendars
- I. Load Shed Mode: An automatic load shedding mode shall be available where, when activated through the system, the control unit will reduce its output to a programmable maximum electrical demand load. The system shall not shed more load than required and load shedding priority shall be centrally configurable by control zone or by common uses (i.e., all hallways can be treated as one load shed group), with subsequent load shed priority groupings being utilized until the required defined load has been shed, for either a defined period, or until the demand response input has been removed. Systems that simply select a “load shed scene” whereby there is no guarantee that the defined required load will actually be shed are not acceptable.

- J. Emergency Mode: There shall be a mode, when activated through the system, that will immediately adjust lights to full light output and retain that level until the mode is deactivated in the event of an emergency. This setting shall override all other inputs. The system shall interface with the building emergency monitoring system at a convenient point and not require multiple connections.
- K. Addressing: All ballasts and/or drivers shall be centrally addressable, on a per luminaire or multiple luminaire/zone basis, through the Central Control Software. The basis of design shall utilize 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers connected to an Output Module. To simplify ongoing maintenance, the system shall not require manual recording of addresses for the purpose of start-up or reconfiguration.
- L. Programmable Task Tuning: The light output level of an individual or group of luminaires shall be programmed via system software.
- M. Continuous Dimming: Individual or group of luminaires dimming in response to user initiated action and/or system generated signal shall be over continuous range.
- N. Unoccupied State: The system shall provide two states when occupancy status is vacant as per an occupancy sensor - lights turn off or lights adjust to configurable (dimmed) light level.
- O. Occupied State: The system shall be capable of creating "comfort" or "support" zones to ensure that occupants are not isolated by turning off lights in adjacent areas, such as a hallway path to exit the premises for occupant comfort and safety.
- P. Overlapping Zones: System shall be capable of creating "overlapping" zones to ensure continuous lighting and safety of the occupants as they move from one lighting zone to another (for example, hallways) while minimizing the energy use.
- Q. Participation in Intelligent Building Framework: The system shall have the ability to be a component of Intelligent Building framework. Wireless Managers and System server communication shall be based on TCP/IP over Ethernet backbone.
- R. LAN Operations: System shall be capable of operating independent of building's existing network infrastructure if desired and shall not rely on tenant supplied PCs for operation. Network infrastructure shall only be utilized for Personal Control Software.
- S. Network Security: Firewall Technologies & VLAN Configuration methods shall be utilized to separate tenants from the lighting control network and ensure the integrity of lighting control network.
- T. Lamp Burn In: The system software shall have the capability of not permitting dimming of new lamps prior to completion of lamp manufacturer recommended accumulated operation at full brightness.
- U. Lighting Maintenance:
 - 1. System software shall notify wireless low battery, lamp or ballast failure events via system & email messages.
 - 2. Wireless devices hop count, route of the signal, signal strength & battery voltage levels shall be available via GUI.
 - 3. Percentage left in Lamp & Ballast Life Time shall be programmed to display in different colors for easier visual representation and quicker maintenance turnaround time.
 - 4. 0-10V Dimming and/or Fixed Output Ballast/LED Driver replacements shall not require re-programming of the system or re-addressing of the said components.
- V. Group (zone) Configuration: The assignment of individual or group of system components to zones shall be performed via Central Control Software such that physical rewiring will not be

necessary when workspace reconfiguration or re-zoning is performed. Removal of covers, faceplates, ceiling tiles, etc. shall not be required.

- W. Sensor Control Parameters: Occupancy sensor time delays shall be configurable through software. Light level sensor parameters shall be configurable through software.
- X. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight savings time and shall provide weekly routine and annual holiday scheduling.
- Y. The system software shall have the capability of providing an optional web based energy dashboard to show real time energy savings data and carbon footprint reductions.
- Z. Contact closure input: System shall be capable of receiving a momentary and sustained contact closure input from third party sources to control lighting zones.
- AA. The system shall have the ability to control (dim/switch) a group of luminaires with loads up to 20A.
- BB. Plug Load Control: The system shall offer occupancy sensing or time schedule based plug load control capability.
- CC. Astronomical Clock feature: Luminaires switch ON/OFF with the sunset and sunrise (with an option to select offset, depending on the geographic location (latitude & longitude) of the building. An offset option shall be available to turn the schedule ON/OFF up to 12 hours before or after dusk or dawn.
- DD. System shall auto-configure lighting controls for spaces that have been combined or divided temporarily by moving wall or similar systems.
- EE. White Light Tuning: System shall emulate the changing colors of the natural daylighting cycle via continuous and smooth tuning of white light sources. Daylight tracking shall be via longitude and latitude settings specific to the building's astronomical location. Speed of transition and color representation shall be based on the luminaire, its source/s and the sunrise/sunset times.
- FF. System shall automatically lock wallstations and/or disable sensors based on one of the following system inputs: contact closure, a time schedule or the status of a monitored space.
- GG. BAS Interface: The light management system shall be capable of interfacing digitally with a building automation system via either BACnet/IP or Tridium Niagara AX interface. The lighting control system shall be capable of communicating the status of output devices (lighting loads) as well as input devices (dry contacts, switches, occupancy sensors, vacancy sensors, and photocells) to the BAS. Building Automation System, utilize data from lighting control system input devices such as occupancy sensors to determine the status (occupied/unoccupied) of the mechanical control zones and perform climate adjustments accordingly.
- HH. AV Interface: The light management system shall be capable of interfacing with audio-visual system (e.g. LCD Touch Screen Panel) via TCP/IP interface.
- II. Migration plan to control LED luminaire: System shall be capable of migrating from the control of 0-10V Ballasts to 0-10V LED Drivers utilizing the same control hardware.
- JJ. AC Phase Cut Dimming circuit Integration: System shall have the ability to control Incandescent, Fluorescent or LED lighting load that are otherwise controlled by manual AC Phase Cut Dimmers.
- KK. Wireless networks shall be reliable (mesh topology), self-configuring (discovery) and self-healing. Unexpected interruptions in the network shall be automatically compensated for by re-directing communication.
- LL. Wireless network shall provide high level of security by employing logically unbreakable secure encryption methods (e.g. 128-bit encryption).

MM. System design shall ensure seamless communication among devices when hybrid wired/wireless control systems are implemented. Hybrid control system refers to devices that communicate over a DALI/0-10V field bus and/or wireless medium that uses non-proprietary open protocol (e.g. ZigBee) for communication. Devices in the hybrid control system shall communicate with all the devices in the system regardless of their native protocol they are designed to work with.

1. Luminaires enable wireless communication either via add-on or integrated modules

2.3 WIRELESS WALLSTATIONS

A. General: The system shall connect with the wallstations via wireless medium that uses non-proprietary open protocol (e.g. ZigBee) for communication.

1. Software configurable wall station shall provide on/off switching and dimming control for up to six lighting zones/ five lighting scenes per wallstation or more with allowable multi-gang configurations.
2. Shall allow manual dimming of light levels and override of the time schedule.
3. Scenes/zones in the system control software shall be synchronized with the buttons on the wallstation.
4. Addressing: All wallstations shall be individually addressable & reconfigurable via system Control Software.
5. LED's: All wall stations shall feature status LED's
6. Lighting scenes shall automatically reconfigure based on scene changes from personal control software.

B. Electrical:

1. Class 2 Low Voltage device
2. Power source: 2-AA/4-AAA 10-year life Alkaline batteries

C. Communication: Shall be via wireless medium that uses non-proprietary open protocol (e.g. ZigBee) for communication

1. Wireless networks shall be reliable (mesh topology), self-configuring (discovery) and self-healing. Unexpected interruptions in the network shall be automatically compensated for by re-directing communication.
2. Wireless network shall provide high level of security by employing logically unbreakable secure encryption methods (e.g. 128-bit encryption).

D. Performance:

1. Wallstation configuration shall be via GUI in a drag and drop format
 - a. Custom button cap configuration shall allow combination of scene & zone in one wallstation
 - b. Custom commands shall be applied to individual wallstation buttons
 - c. Status LED: Wall station shall display its current status (zone/scene under system control or OFF) when motion is detected in the close proximity of the wallstation
2. The following User Interface and custom labelling options shall be available:
 - a. Up to five (5) scene switching & dimming
 - b. Up to six (6) zone switching
 - c. One (1) zone switching
3. Shall have icons that will illuminate when Loss of communication with the system control unit, Fire Alarm & Wallstation Lock statuses are detected.
4. Shall allow vacancy sensor configuration
5. The battery life statuses of wireless wallstations shall be monitored via GUI.

E. Mechanical:

1. Dimensions: Shall meet NEMA WD-6 spec.
2. Color: Shall meet NEMA WD1 color specifications
3. The following mounting options shall be supported:
 - a. Surface mount
 - b. Mount in standard size wall box
 - c. On mounting brackets for low voltage devices
4. Shall provide support for "Decorator" style wall plate installation

F. Reliability:

1. Operating temperature range: +14 deg F (-10 deg C) to 104 deg F (40 deg C)
2. Humidity: 5% to 95% RH non-condensing rated for indoor locations.

G. Regulatory:

1. Safety: UL916 listed
2. Environmental protection: Rated for dry location; RoHS compliant
3. Radio Interference: FCC Part 15/ICES-003
4. Shall comply or exceed the following electromagnetic requirements:
 - a. EN 61000-4-2
 - b. EN 61000-4-4
 - c. EN 61000-4-5

2.4 LOW VOLTAGE WALLSTATIONS

A. General: The system shall connect with the wallstations via field bus that carry 0-10V control signals.

1. Software configurable wall station shall provide on/off switching and dimming control for up to six lighting zones/ five lighting scenes per wallstation or more with allowable multi-gang configurations.
2. Shall allow manual dimming of light levels and override of the time schedule.
3. Scenes/zones in the system control software shall be synchronized with the buttons on the wallstation.
4. Addressing: All wallstations shall be individually addressable & reconfigurable via System Control Software.
5. LED's: All wall stations shall feature status LED's
6. Lighting scenes shall automatically reconfigure based on scene changes from personal control software.

B. Electrical:

1. Class 2 Low Voltage device
2. Power source: Communication bus

C. Communication: Shall be via NEC/CEC Class 2 communication wire

D. Performance:

1. Wallstation configuration shall be via GUI in a drag and drop format
 - a. Custom button cap configuration shall allow combination of scene & zone in one wallstation
 - b. Custom commands shall be applied to individual wallstation buttons

- c. Status LED: Wall station shall display its current status (zone/scene under system control or OFF) when motion is detected in the close proximity of the wallstation
 - 2. The following User Interface and custom labelling options shall be available:
 - a. Up to five (5) scene switching & dimming
 - b. Up to six (6) zone switching
 - c. One (1) zone switching
 - 3. Shall have icons that will illuminate when Loss of communication with the system control unit, Fire Alarm & Wallstation Lock statuses are detected.
 - 4. Shall allow vacancy sensor configuration
- E. Mechanical:
 - 1. Dimensions: Shall meet NEMA WD-6 spec.
 - 2. Color: Shall meet NEMA WD1 color specifications
 - 3. The following mounting options shall be supported:
 - a. Mount in standard size wall box
 - b. On mounting brackets for low voltage devices
 - 4. Shall be used with "Decorator" style wall plate
- F. Reliability:
 - 1. Operating temperature range: 14 deg F (-10 deg C) to 140 deg F (60 deg C)
 - 2. Humidity: 5% to 95% RH non-condensing rated for indoor locations.
- G. Regulatory:
 - 1. Safety: UL916 listed
 - 2. Environmental protection: Rated for dry location; RoHS compliant
 - 3. Radio Interference: FCC Part 15/ICES-003
 - 4. Shall comply or exceed the following electromagnetic requirements:
 - a. EN 61000-4-2
 - b. EN 61000-4-4
 - c. EN 61000-4-5

2.5 TOUCH SCREEN PANEL

- A. General: Shall enable the ability to display light level, status and recall multiple lighting scenes.
- H. Electrical:
 - 1. Input voltage: Shall be via Power over Ethernet or +9VDC to +16VDC, 1A max.
- I. Communication: Shall be via Ethernet connection that employs TCP/IP protocol
- J. Performance:
 - 1. Full color 7" TFT LCD, Full VGA (800 x 480 pixels) with 65K colors
 - 2. CPU: 32 bit, 533 MHz
 - 3. Memory: 128 Non-volatile Flash Memory
 - 4. Flexible configurations for custom buttons, text and graphics
 - 5. Integrated high-resolution capacitive touch screen
- K. Mechanical: Shall be wall mountable

- L. Reliability:
 - 1. Operating Temperature Range: -32 deg F (0 deg C) to +122 deg F (+50 deg C)
 - 2. Humidity: 0% to 95% RH non-condensing rated for indoor locations

2.6 WIRELESS CONTROL MODULES (WCM)

- A. General: Wireless Modules shall enable wireless connectivity to 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers. Addresses to the wireless modules shall be assigned during system start-up. Upon establishing two way communication with the Wireless Manager, these individually addressable modules shall enable each lighting component to be independently controlled and configured to best meet the needs of the facility.
 - 1. Addressing: Wireless Modules shall be individually addressable via System Control Software.
 - 2. System shall automatically address individual wireless modules during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
- B. Electrical: Ratings for Ballast/General purpose/Tungsten shall be: 120V – 347VAC (+/-10%)
- C. Communication: Shall be via wireless medium that uses non-proprietary open protocol (e.g. ZigBee) for communication
 - 1. Wireless networks shall be reliable (mesh topology), self-configuring (discovery) and self-healing. Unexpected interruptions in the network shall be automatically compensated for by re-directing communication.
 - 2. Wireless network shall provide high level of security by employing logically unbreakable secure encryption methods (e.g. 128-bit encryption).
 - 3. Shall connect to NEC/CEC Class 2 communication wire
- D. Performance:
 - 1. Control Options
 - a. ON/OFF Switching
 - b. Continuous 0-10V dimming
 - 2. Air Gap Off: Shall enforce physical disconnection of AC power to the ballast or driver when “OFF” is selected either automatically or manually.
 - 3. Shall be able communicate with 0-10V ballasts/drivers as well as DALI ballasts/drivers
 - 4. Shall enable wireless connection to low-voltage infrared, ultrasonic, and multi-technology sensors, Relay based Lighting Control Panels, and AC Phase Cut Dimming Modules.
 - 5. Shall be used to extend wireless network capability
 - 6. Memory: Shall retain all system settings in non-volatile memory
- E. Mechanical:
 - 1. Dual mounting: Mounts inside a standard (4" x 4") j-Box or to ½" knock-out
 - 2. Material: Plenum rated black plastic (UL2043)
- F. Reliability:
 - 1. Operating temperature range: -40 deg F (-40 deg C) to 140 deg F (60 deg C)
 - 2. Humidity: 5% to 95% RH non-condensing rated for indoor locations.
- G. Regulatory:
 - 1. Safety: UL916, UL924 & UL2043 listed
 - 2. Environmental protection: Rated for damp location (IP54); RoHS compliant

3. Radio Interference: FCC Part 15/ICES-003
4. Complies with the following electromagnetic requirements:
 - a. EN 61000-4-2
 - b. EN 61000-4-4
 - c. EN 61000-4-5

2.7 CONNECTED LIGHTING MODULES (CLM)

- A. General: Connected Lighting Modules enable wireless connectivity to individual or group of luminaires with 0-10V Dimming ballasts and/or 0-10V LED Drivers. Addresses to these luminaire integrated modules shall be assigned during system start-up. Upon establishing two way communication with the Wireless Manager, these individually addressable modules shall enable individual or group control and configuration of lighting component/s.
 1. Addressing: Connected Lighting Modules shall be individually addressable via System Control Software.
 2. System shall automatically address individual modules during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
- B. Electrical:
 1. Input Voltage: 12VDC (+/- 10%)
 2. Input Current: 20mA avg
 3. Power Consumption: 2.4W avg.
- C. Communication: Shall be via wireless medium that uses non-proprietary open protocol (e.g. ZigBee) for communication
 1. Wireless networks shall be reliable (mesh topology), self-configuring (discovery) and self-healing. Unexpected interruptions in the network shall be automatically compensated for by re-directing communication.
 2. Wireless network shall provide high level of security by employing secure encryption methods (e.g. 128-bit encryption).
- D. Performance:
 1. Control Options: Continuous 0-10V dimming
 2. Group Control: Shall control up to 0-10V ballasts/LED drivers
 3. Shall be used to extend wireless network capability
 4. Memory: Shall retain all system settings in non-volatile memory
- H. Mechanical:
 1. Luminaire Mounting: Via ½" knock-out
 2. Material: Plenum rated plastic (UL2043)
- I. Reliability:
 1. Operating temperature range: -40 deg F (-40 deg C) to 140 deg F (60 deg C)
 2. Humidity: 5% to 95% RH non-condensing rated for indoor locations.
- J. Regulatory:
 1. Safety: UL916 & UL2043 listed
 2. Certification: ZHA
 3. Environmental protection: Rated for damp location (IP54); RoHS compliant
 4. Radio Interference: FCC Part 15
 5. Complies with the following electromagnetic requirements:

- a. EN 61000-4-2
- b. EN 61000-4-4
- c. EN 61000-4-5

2.8 WIRELESS AREA LIGHTING CONTROLLER (WALC)

- A. General: Shall provide a common interface (DIM/SWITCH) to a group of 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers over wireless medium that uses non-proprietary open protocol for communication.
 - 1. Addressing: Area Lighting Controllers shall be addressable via Control Software.
 - 2. System shall automatically address individual wireless area lighting controllers during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
- B. Electrical:
 - 1. Maximum Load Ratings:
 - a. 20A 120-347 Vac Ballast
 - b. 20A 120-347 Vac Resistive
 - c. 20A 120-347 Vac Tungsten
 - d. 20A 120-347 Vac General Purpose
 - e. 1.5 HP 120-277 Vac Motor
- C. Communication: Shall be via wireless medium that uses non-proprietary open protocol (e.g. ZigBee) for communication
 - 1. Wireless networks shall be reliable (mesh topology), self-configuring (discovery) and self-healing. Unexpected interruptions in the network shall be automatically compensated for by re-directing communication.
 - 2. Wireless network shall provide high level of security by employing logically unbreakable secure encryption methods (e.g. 128-bit encryption).
 - 3. Shall connect to NEC/CEC Class 2 communication wire
- D. Communication: Shall be via wireless medium that uses non-proprietary open protocol (e.g. ZigBee)
- E. Performance:
 - 1. Control Options
 - a. ON/OFF Switching
 - b. Continuous 0-10V dimming
 - c. Shall be able to communicate with 0-10V ballasts/drivers
 - 2. Shall be used for general purpose plug load control
 - 3. Group Control: Shall control up to 50 ballast/LED Drivers
 - 4. Shall enable direct 0-10V sensor connection
 - 5. Shall enable wireless connection to low-voltage infrared, ultrasonic, and multi-technology sensors, Relay based Lighting Control Panels and AC Phase Cut Dimming Modules.
 - 6. Air Gap Off: Shall enforce physical disconnection of AC power to the ballast or driver when "OFF" is selected either automatically or manually.
 - 7. Memory: Shall retain all system settings in non-volatile memory
- F. Mechanical:
 - 1. Mounting: Standard 1/2" electrical box knockout
 - 2. Material: Plenum rated black plastic (UL2043)

- G. Reliability:
1. Operating temperature range (wireless): -40 deg F (-40 deg C) to 149 deg F (65 deg C)
 2. Humidity: 5% to 95% RH non-condensing rated for indoor locations

- H. Regulatory:
1. Safety: UL916, UL924 & UL2043 listed
 2. Environmental protection: Rated for damp location; RoHS compliant
 3. Radio Interference: FCC Part 15/ICES-003
 4. Shall comply or exceed the following electromagnetic requirements:
 - a. EN 61000-4-2
 - b. EN 61000-4-4
 - c. EN 61000-4-5

2.9 COMMUNICATION WIRE (GREENBUS)

- A. General: The system shall have the capability to use both NEC/CEC Class 1 and Class 2 wiring to integrate peripheral devices such as ballasts/LED drivers, occupancy sensors, photo sensors, relay-based controls, area lighting controllers, wireless sensors and wallstations into a complete, networked programmable lighting control system.
- B. Electrical: NEC/CEC Class 2 Communication bus
- C. Mechanical:
1. Multi-conductor cable with stranded-copper conductors
- D. Performance:
1. Shall power photo sensors, PIR and dual-technology occupancy sensors.
 2. Shall allow random devices connection without the need for special network channel termination.
 3. Minimize system down time by self-diagnosing the field bus for any shorts and open loops.
- E. Regulatory:
1. Flame rated jacket for plenum use NFPA 262 (UL: FT6, CSA: CMP).

2.10 RELAY BASED LIGHTING CONTROL PANELS (RP/RPM)

- A. General: An addressable lighting control panel that allows each relay to be individually controlled and configured.
1. Addressing: All lighting control panel relays shall be individually addressable via Central Control Software.
 2. Relay Panel Modules are suitable for 35 mm DIN rail mounting.
- B. Electrical:
1. Input Power Supply: 40 VA, 50/60 Hz
- C. Communication:
1. Shall be via NEC/CEC Class 2 communication wire
 2. Wireless communication shall be enabled via Wireless Control Module/Wireless Area Lighting Controller

- D. Performance: ON/OFF Switching at Circuit level
- E. Reliability:
 - 1. Maximum Operating Ambient Temperature: 140 deg F (60 deg C).
- F. Regulatory:
 - 1. Safety: UL916, UL924 listed
 - 2. Radio Interference: FCC Part 15/ICES-003
 - 3. Shall comply or exceed the following electromagnetic requirements:
 - a. EN 61000-4-2
 - b. EN 61000-4-4
 - c. EN 61000-4-5

2.11 AC PHASE CUT DIMMING MODULE (PCDM)

- A. General: AC Phase Cut Dimming Modules shall provide a common interface to a group of Incandescent, Fluorescent or LED light systems that are otherwise connected to manual forward/reverse phase cut dimming devices.
 - 1. Addressing: AC Phase Cut Dimming Modules shall be individually addressable via Central Control Software.
- B. Electrical:
 - 1. Input Voltage: 120-277 VAC 50/60Hz
 - 2. Maximum Output Load Ratings shall be:
 - a. 120 VAC: 450W, 3.8 A MAX
 - b. 277 VAC: 900W, 3.3 A MAX
 - 3. Shall have built-in short circuit protection
 - 4. Shall offer ANSI C62.41 Category A Transient protection
- B. Communication:
 - 1. Shall be via NEC/CEC Class 2 communication wire
 - 2. Wireless communication shall be enabled via Wireless Control Module/Wireless Area Lighting Controller
- C. Performance:
 - 1. Shall provide an interface between the phase cut dimmable (forward and reverse phase) ballasts/LED drivers
 - 2. Shall have configuration stored in non-volatile flash memory.
- D. Mechanical:
 - 1. Dimensions: 4.75" W X 5.0" L X 2.24" H (120.7mm W x 127mm L X 56.9mm H)
 - 2. Installation on top of a standard square 4 11/16" junction box
- E. Reliability:
 - 1. Operating temperature range: 32 deg F (0 deg C) to 104 deg F (40 deg C)
 - 2. Case Temperature: up to 158 deg F (70 deg C)
 - 3. Suitable for indoor dry locations only
- F. Regulatory:

1. Safety: UL916, UL924 listed
2. Radio Interference: FCC 47 CFR Part 18
3. Shall comply or exceed the following electromagnetic requirements:
 - a. EN 61000-4-2

2.12 LOW VOLTAGE PHOTO SENSOR

- A. General: Photo sensor connectivity shall be via field bus that carry 0-10V control signals.
- B. Electrical:
 1. Class 2 Low Voltage device
 2. Power source: Communication bus
- C. Communication:
 1. Shall be via Class 2 communication bus
 2. Wireless communication shall be enabled via Wireless Control Module/Wireless Area Lighting Controller
- D. Performance:
 1. Accuracy: +/-1% at 21 deg C (70 deg F), derated to +/-5% at 49 deg C (120 deg F) or at -18 deg C (0 deg F).
 2. The indoor sensor range shall be between 0 and 750 FC.
 3. The Outdoor sensor range shall be between 0 and 750 FC.
 4. Atrium sensor range shall be from 2 to 2,500 FC.
 5. Skylight sensor range shall be between 10 and 7,500 FC.
- E. Mechanical:
 1. Mounting options shall include the following:
 - a. Junction Box mounting
 - b. Knock-out mounting
- F. Reliability:
 1. Operating temperature range: 13 deg F ((-11 deg C) to +140 deg F (60 deg C)
 2. Humidity: 5% to 95% RH (non-condensing)

2.13 LOW VOLTAGE OCCUPANCY SENSORS (PIR, ULTRASONIC OR DUAL-TECHNOLOGY)

- A. General: Occupancy sensor connectivity shall be via field bus that carry 0-10V control signals.
 1. Shall allow timeouts configurable via system software.
 2. Sensors using passive infrared, ultrasonic, microphonic, and multi-technology shall be available.
 3. Shall allow occupancy and vacancy sensor configurations via system software.
 4. Depending on the software configuration shall switch or dim the luminaires.
 5. Shall allow overlapping and comfort zone configurations via system software.
- B. Electrical:
 1. Class 2 Low Voltage device
 2. Power source: Communication bus
- C. Communication:

1. Shall be via Class 2 communication bus
2. Wireless communication shall be enabled via Wireless Control Module/Wireless Area Lighting Controller

D. Performance:

1. Shall allow flexible timer settings
2. Shall have the ability to self-calibrate and retain settings during power interruptions
3. Shall have the ability to automatically analyze and adjust sensitivity and time delay
4. Shall provide the following coverage:
 - a. Ceiling mount: 450 sq. ft. to 2000 sq. ft.
 - b. Wall mount: 1200 sq. ft. to 2500 sq. ft.

E. Mechanical:

1. Wired: Sensors for mounting on ceilings and walls, including corners, shall be available.

F. Reliability:

1. Operating temperature range: 32 deg F to +104 deg F. (0 deg C to 40 deg C)
2. Humidity: 0% to 95% RH (non-condensing)

2.14 WIRELESS SENSORS

A. Sensors shall have built-in occupancy & daylight sensing capability. Shall connect to the Lighting Control System via wireless medium that uses non-proprietary open protocol for communication.

B. Electrical:

1. Class 2 Low Voltage device
 - a. Power source: Two (2) AA Alkaline batteries or equivalent with 10-year battery life

C. Communication: Shall be via wireless medium that uses non-proprietary open protocol (e.g. ZigBee) for communication

1. Wireless networks shall be reliable (mesh topology), self-configuring (discovery) and self-healing. Unexpected interruptions in the network shall be automatically compensated for by re-directing communication.
2. Wireless network shall provide high level of security by employing logically unbreakable secure encryption methods (e.g. 128-bit encryption).

D. Performance:

1. Shall perform both occupancy and daylight harvesting
2. The battery life shall be monitored via system software.
3. Indicator light: Indicator light to signify different sensor statuses (failure, start-up, etc.)
4. Tool less mounting options shall be available:
 - a. Invisible mark mounting
 - b. Magnetic mounting
5. Sensor timeouts shall be configurable via system software.
6. Occupancy/Vacancy sensor configurations shall be performed via system software.
7. Depending on the software configuration shall switch or dim the luminaires.
8. Shall allow overlapping and comfort zone configurations via system software.
9. Shall supply a wireless signal to the Lighting Management System proportional to the light measured.

10. Shall provide the daylight sensor range shall be between 0 and 100 FC (0 to 1000 Lux)
11. Shall provide the following occupancy coverage:
 - a. 450 sq. ft. with micro-motion sensitivity
 - b. 1500 sq. ft. long range with high sensitivity core

E. Mechanical:

1. Dimensions: 3.37" diameter (85.49mm) x 1.13" (28.6mm) height (standard range) / 0.98" (25mm) height (long range)
2. Mounting
 - a. The following tool less mounting options shall be available:
 - 1) Invisible mark mounting
 - 2) Magnetic mounting
 - b. Other mounting options shall include the following:
 - 1) Junction Box mounting
 - 2) Knock-out mounting
3. Plastic material

F. Reliability:

1. Operating temperature range: 32 deg F to 104 deg F (0 deg C to 40 deg C)
2. Humidity: 5% to 95% RH (non-condensing)

G. Regulatory:

1. Environmental protection: Rated for dry location; RoHS compliant

1.2 WIRELESS MANAGER (WM)

- A. General: The wireless manager shall be the central intelligence point for the area that it controls, collecting signal information from sensors, wallstations and personal control software and determining appropriate brightness levels or on/off status for each luminaire or zone. Each wireless manager shall control large quantity of wireless devices. The wireless manager shall automatically detect and during start-up addresses the compatible sensors, wallstations & system field devices it is connected to and establishes two-way communication.

The wireless manager shall communicate with the server over Ethernet connection that employs TCP/IP protocol. The wireless manager shall connect with a facility's or tenant's Local Area Network (LAN) via Ethernet connection to enable desktop personal control.

B. Electrical:

1. Input voltage: Via Power over Ethernet

- C. Communication: Shall be via wireless medium that uses non-proprietary open protocol (e.g. ZigBee) for communication

1. Wireless networks shall be reliable (mesh topology), self-configuring (discovery) and self-healing. Unexpected interruptions in the network shall be automatically compensated for by re-directing communication.
2. Wireless network shall provide high level of security by employing logically unbreakable secure encryption methods (e.g. 128-bit encryption).
3. Server communication shall be via TCP/IP over Ethernet

D. Mechanical:

1. Plastic material
2. Mounting: Ceiling or wall mount via j-box

E. Visualization & Performance:

1. Manages large number of nodes
2. Shall appear in system software
3. Shall be configured via system software
4. Shall display transmit/receive signal strength with the nodes on the floor plan
5. Shall display hop count information with the nodes on the floor plan

F. Reliability:

1. Ambient temperature range: 32 deg F (0 deg C) to 104 deg F (40 deg C)
2. Humidity: 5% to 95% RH non-condensing rated for indoor locations.

G. Regulatory:

1. Safety: UL916 listed
2. Environmental protection: Rated for dry location; RoHS compliant
3. Radio Interference: FCC Part 15/ICES-003
4. Complies with the following electromagnetic requirements:
 - a. EN 61000-4-2
 - b. EN 61000-4-4
 - c. EN 61000-4-5

2.15 SYSTEM SERVER (SSU)

- A. General: System Server shall host the lighting control system database for all the lighting control devices. In addition, it shall provide remote accessing capability to change system settings and/or parameters.

Server shall have the ability to:

1. Analyze system performance or energy data or generate system report;
2. Record energy consumption with average sampling every 5 minutes for unlimited duration;
3. Host the web interface required for the web enabled Personal Control Software or web based Central Control Software;
4. Reside on a client server (virtual server) thus eliminating the need for dedicated physical hardware if desired;
5. Interconnect with Wireless Managers over standard Ethernet connection that employs TCP/IP protocol;

B. Electrical:

1. Power Supply: 120V/60Hz/200W. Provide dedicated 120V receptacle fed from a dedicated normal power circuit.

C. Communication:

1. Each System Server shall have two Ethernet 10/100Base - Tx Cat 5 RJ45 ports that employ TCP/IP protocol.

D. Mechanical:

1. Shall mount in a standard 19" rack (1U width), or alternatively where no rack is shown, via an individual wall mount.

E. Reliability:

1. Operating temperature range: 50 deg F (10 deg C) to 95 deg F (35 deg C)
2. Operating Relative Humidity: 10% to 90% (non-condensing)

F. Regulatory:

1. FCC (US only) Class A.
2. DOC (Canada) Class A.
3. UL 60950.
4. CAN/CSA-C22.2 No. 60950.

2.16 LIGHTING CONTROL SYSTEM SOFTWARE

- A. Personal Control Software: Shall enable individuals in a building to control lighting levels in their workspace from their own desktop PC. Shall enable light level control for each luminaire in their workspace or control all of the luminaire together as a group. Preset lighting scenes shall be stored, recalled and modified. This software shall have the capability of acting as a "virtual occupancy sensor" for the system by detecting keyboard or mouse activity on each PC for incremental occupancy status data.

1. Technical Information:

- a. TCP/IP network traffic < 2kb/s.

- B. Web based Personal Control Software: Shall enable majority of the Personal Control Software features via a web browser. Shall allow tasks such as individual luminaire dimming control, on/off switching, modify and save preset lighting scenes.

- C. Technical Information: Adobe Flash ® based user interface.

1. System shall require:

- a. Internet web browser with Flash® Player 8 or later.
- b. Internet/Intranet connection.
- c. SSU enabled and configured to host dynamic website.
- d. Network connection with access to a network-enabled WM.

- D. Web based Central Control Software: Central control software application shall be used to start-up, configure and manage the system. Every system parameter in a building (or campus of buildings) shall be configured for each individual user or space and baseline settings shall be established for each of the following (depending on the basis of design) system features:

1. Daylight harvesting.
2. Occupancy control.
3. Smart time scheduling.
4. Task tuning.
5. Personal control.
6. Load shedding.
7. Software shall utilize a web based interface that permits a user to easily navigate between zones, floors or different buildings and allows a user to zoom in or zoom out of specific areas of a building. Both 3-dimensional and two-dimensional multi-floor views shall be available. System features such as creation of zone hierarchies, overlapping and support zone definitions, user access rights, timeout settings for occupancy sensors, calibration of light levels for daylight harvesting and the configuration of multiple time schedule profiles shall be available. A web based Graphical User Interface (GUI)

application integral to the system shall be used to develop a dynamic, real-time, point-and-click graphic of each floor plan with representation of all light luminaire, wallstations, sensors, switches, etc. A central system server shall be provided to support system data base and enterprise control management.

8. System shall require:
 - a. Software that can run on a Windows Operating systems (Windows XP or newer) and also on Apple Mac Intel PCs (Mac OS 10.4 or newer).
 - b. Ability to support all common browsers, i.e.,
 - 1) Internet Explorer 6.0 or later
 - 2) Mozilla Firefox 3.0 or later
 - 3) Safari
 - 4) Google Chrome
 - c. Network connection/access to all network-enabled CUs.
 - d. Native Energy Performance Monitoring capability
 - e. Color gradient ("weather map" type) data view (see below for an example) to display the following criteria:
 - 1) Lamp & ballast life time
 - 2) Current energy consumption
 - 3) Current energy savings
 - 4) Current luminaire brightness
 - 5) Current luminaire status
 - 6) Current occupancy data
 - 7) Current load shedding status
 - 8) Hop count
 - 9) Route of the signal
 - 10) Signal Strength
 - 11) Battery Voltage Status
 - 12) Other custom modes that may be specified elsewhere

2.17 AUDIO-VISUAL INTERFACE

- A. General: Shall allow users command (e.g. LCD Touch Screen Panel) various lighting scenarios depending on the audio & visual requirements of the room or building.
 1. The lighting control system shall interface to the AV system via TCP/IP protocol using Telnet.
 2. The lighting control system shall allow a common AV processor to individually control multiple rooms from a single TCP/IP port through unique room, zone, and scene addresses for lighting in each room.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Site Verification: Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instructions.
- B. Inspection: Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

3.2 INSTALLATION

- A. The Electrical Contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all equipment. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control as described herein and shown on the plans (including but not limited to System Field Devices, 0-10V dimming ballasts, fixed output ballasts, 0-10V LED drivers and communication wire). The Electrical Contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.
- B. Power: The contractor shall test that all branch load circuits are operational before connecting loads to sensor system load terminals, and then de-energize all circuits before installation.
- C. Related Product Installation: Refer to other sections listed in Related Sections for related products' installation.

3.3 SENSOR INSTALLATION

- A. Adjust sensitivity to cover area installed
- B. Set time delay on occupancy sensors that are connect to the lighting control system to the minimum. Time delays shall be controlled via Central Control Software.
- C. Vacancy sensor configurations shall be via Central Control Software.
- D. Sensors shall be powered through Input Module, Wireless Control Module, Kinetic energy or batteries.
- E. Install occupancy sensors on vibration free stable surface.
- F. Install atrium and skylight light sensor facing toward window or skylight.
- G. Install interior light sensor in ceiling facing the floor.

3.4 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4 inch.
- B. Wiring within Enclosures: Comply with NEC & CEC. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 SOFTWARE INSTALLATION

- A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current site licenses for software.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following field tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing wallstations and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Lighting control devices will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
- 3.7 SYSTEM START-UP REQUIREMENTS & SUPPORT SERVICES
- A. System Start-up: The manufacturer shall supply factory trained representatives to start-up the lighting control system.
- B. Training: As part of the system start-up service, the provider of the service shall train the facility staff, or end users, responsible for changing the lighting characteristics in a building in the operation of the system. The start-up service provider shall also provide owner's representatives with system operating manuals.
- C. Extended Service Coverage: Maintenance agreements shall be available from the manufacturer to provide service for the system both during and after the warranty period.
- D. Requests for start-up or technical services shall be at least fifteen (15) business days prior to date desired for service.
- E. Electrical contractor shall perform functional testing under the guidance of technical service agent and in accordance with factory specified guidelines.
- F. Technical service provider shall provide technical services for the lighting control system.
1. Verify proper communication over control wires.
 2. Map addresses of all devices.
 3. Verify communication to wireless managers and system server.
 4. Software configuration of occupancy sensors, light level sensors, wallstations and other contacts to suit design specifications.
 5. Configure and program lighting control sequences as described on contract documents.
 6. Demonstrate to Owner and Engineer proper operation of all areas the system is installed.

3.8 TESTING

- A. Upon completion of all line, load and interconnection wiring, and after all luminaire are installed and lamped, a qualified factory representative shall completely configure and test the system.
- B. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.

3.9 DEMONSTRATION

- A. The provider of the service shall train the facility staff, or end users, responsible for changing the lighting characteristics in a building to adjust, operate, utilize, troubleshoot, conduct software installation, and maintain lighting controls and software training for PC-based control systems.

END OF SECTION 260934

SECTION 260935 – TIME SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Applicable provisions of the General Conditions, Supplementary General Conditions and Special Conditions shall govern work performed under this section.
- B. Section 260000 - Electrical General Conditions.
- C. Section 260010 - Basic Electrical Materials and Methods.

1.2 WORK INCLUDED

- A. Time switches.

1.3 QUALITY ASSURANCE

- A. Units, and all accessories, shall be listed by Underwriter's Laboratories, Inc. and bear the appropriate UL label.

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 260000.
- B. Submit shop drawings, product data, manufacturer's installation instructions and operation and maintenance data for manufactured products and assemblies required for this project.
- C. Indicate electrical service connections on shop drawings or product data.
- D. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

PART 2 - PRODUCTS

2.1 ELECTRONIC TIME SWITCH

- A. Manufacturer and model number given are intended to establish desired type, quality and performance. Equivalent products of the following manufacturers are equally acceptable:
 - 1. Intermatic ET8415CR series
 - 2. Paragon
 - 3. Tork
- B. Time switch shall be a 7-day Astronomic Electronic Time Switch with solid state electronic control capable of permitting 56 Event set points per circuit to be distributed on independent daily schedules. 4 Circuits.
- C. The time switch shall include a 7-day repeat feature for simplifying programming of set points.
- D. The timer shall have a digital LCD readout to show day of week, time-of-day and date using 12 hour AM/PM indicator.
- E. The time switch shall provide a manual override control for both temporary and/or override.
- F. The time switch shall operate over a temperature range of -40°F to 155°F.
- G. Industrial grade AAA alkaline batteries shall protect time-of-day for a minimum of 3 years; program information shall be in non-volatile memory.

- H. Switch configuration to be SPST with a UL/CSA listed rating of:
 - 1. 30 amp Inductive/Resistive, 24/120/240 volts AC, 60 Hz
 - 2. 20 amps Resistive, 28 VDC
 - 3. 1 HP, 120 volts AC, 60 Hz
 - 4. 2 HP, 240 volts AC, 60 Hz
 - 5. 5 amps Tungsten, 120/240 volts AC, 60 Hz
 - 6. 20 amps Ballast, 120/277 volts AC, 60 Hz
- I. The time switch shall be a 120 volts AC, 60Hz
- J. The time switch shall be enclosed in a lockable steel NEMA 1 rated enclosure.
- K. The time switch shall be UL/CSA listed under UL 916/C22.2-177.
- L. Energy Management Equipment shall be Intermatic Model ET8115/CR.

PART 3 - EXECUTION

- 3.1 Coordinate all locations, size, and installation details of the time switches with the anticipated building construction to insure that they fit the space provided for them.
- 3.2 WIRING INSTALLATION
 - A. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
 - B. Size conductors according to control device manufacturer's written instructions, unless otherwise indicated.
 - C. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- 3.3 IDENTIFICATION
 - A. Identify components and power and control wiring according to Section 260010.
 - B. Identify controlled circuits in lighting contactors.
 - C. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
 - D. Label time switches and contactors with a unique designation.
- 3.4 FIELD QUALITY CONTROL
 - A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
 - B. Control devices that fail tests and inspections are defective work.
- 3.5 ADJUSTING 916/C22.2-177
 - A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to one visit to Project during other-than-normal occupancy hours for this purpose.
- 3.6 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements in other Division 26 Sections.
- 3.7 Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 260935

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