

# SW Park Apartments

## Rystadt

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#### DIVISION 26

#### ELECTRICAL

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## SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

## PART 1 - GENERAL

## 1.01 DESCRIPTION

- A. Division 26 will be responsible to carry out the commissioning requirements specified in Section 26 08 00, 01 91 00 and other sections referenced in 01 91 00.
- B. The provisions of the General Requirements, Supplementary Requirements, and Division 1 apply to the electrical work specified in this Section.
- C. The requirements of this Section apply to the electrical systems specified in these Specifications and in other Division 26 sections.
- D. Provide all items, articles, materials, equipment, operations and/or methods listed, mentioned, shown and/or scheduled on the drawings and/or in these specifications, including all labor, supervision, services, permits, fees, and incidentals necessary and required to provide a complete and operable facility with complete systems as shown, specified, and required by applicable codes.
- E. The work shall include, but not be limited to, the following systems:
  - 1. Electrical service complete per serving utility company requirements.
  - 2. Electric service and distribution equipment.
  - 3. Complete lighting and power systems, including panelboards, branch circuits, devices, lighting fixtures, etc.
  - 4. Telephone service conduit, terminal boards, terminal cabinets, outlets, raceway system, and grounding per utility requirements.
  - 5. Fire alarm central control panel, initiating and annunciating devices, raceway and cabling system, etc.
  - 6. Connection of electrical equipment furnished under other Divisions of this Specification.
  - 7. Wiring to and connection of electrical equipment or appliances furnished outside of these Specifications and Contract but described on the Electrical Drawings.
  - 8. Special systems as specified herein.
  - 9. Grounding.
  - 10. Rough-in provisions for security alarm system.
  - 11. Generator set and associated transfer equipment.
- F. Advise subcontractor, suppliers, and vendors involved in the work specified in this Section of the applicable requirements.
- G. Temporary electrical service, Division 1.

## 1.02 QUALITY ASSURANCE

- A. All work and materials shall conform to all applicable local and state codes and all federal, state and other applicable laws and regulations. All clarifications and modifications which have been cleared with appropriate authorities are listed under the applicable sections. All electrical products shall bear the UL label.

- B. Whenever the requirements of the Specifications or Drawings exceed those of the applicable code or standard, the requirements of the Specifications and Drawings shall govern.
- C. Codes and Standards: Comply with the provisions of the following referenced codes, standards and specifications:
  - 1. Institute of Electrical and Electronic Engineers (IEEE)
  - 2. Federal Specifications (FS)
  - 3. American National Standards Institute (ANSI)
  - 4. National Electrical Manufacturer's Association (NEMA)
  - 5. National Fire Protection Association (NFPA)
  - 6. Underwriters Laboratories, Inc. (UL)
  - 7. Factory Mutual (FM)
  - 8. International Building Code (IBC) with State and Local Amendments
  - 9. National Electrical Code (NEC) with State and Local Amendments
  - 10. American Society for Testing and Materials (ASTM)
  - 11. Americans with Disabilities Act (ADA)
  - 12. International Fire Code (IFC) with State and Local Amendments
  - 13. National Electrical Contractors Association (NECA)
- D. Each piece of equipment furnished shall meet all detailed requirements of the Drawings and Specifications and shall be suitable for the installation shown. Equipment not meeting all requirements will not be acceptable, even though specified by name. Where two or more units of the same class of equipment are furnished, use product of the same manufacturer; component parts of the entire system need not be products of same manufacturer. Furnish all materials and equipment, new and free from defect and of size, make, type and quality herein specified or approved by the Architect. All materials shall be installed in a neat and professional manner.
- E. All apparatus shall be built and installed to deliver its full rated capacity at the efficiency for which it was designed.
- F. All disconnect switches, panelboards, switchboards, motor control centers, and equipment of like nature shall be of the same manufacturer.
- G. The Drawings and Specifications are complementary. What is called for by one shall be as though called for by both. If Drawings and Specifications contradict each other, the Contractor shall obtain written clarification prior to the bid. If time constraints are such that this is not possible, then the more stringent of the conflicting requirements shall be included in the bid. The Specifications are not automatically more authoritative than the drawings.

#### 1.03 WORK OF OTHER CONTRACTS

- A. Work under this contract shall be conducted in a manner to allow for the future installations of such equipment or items, and include the wiring and/or devices shown on the Drawings or listed in other sections of this Specification. Also see "Equipment Connections."

#### 1.04 WORK OF OTHER DIVISIONS

- A. Work under this Division shall be conducted in a manner to cooperate with the installation of such equipment or items as specified in other Divisions.

- B. Control devices and control wiring relating to the heating and air conditioning systems are specified under other Sections of these Specifications except for provisions or items specifically noted on the Drawings or specified herein.
- C. Consult all Drawings and Specifications in this project and become familiar with all equipment to be installed. Coordinate all aspects of the construction with the other trades on the job to ensure that all work and materials required to provide a complete and operational facility are included in the bid.
- D. All sections of Division 26 are interrelated and shall be considered in their entirety when interpreting any material, method, or direction listed in any section of Division 26. Individual sections are not written for specific subcontractors or suppliers but for the General Contractor.

#### 1.05 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

- A. Submit in accordance with Division 1 full technical and descriptive shop drawing data on proposed materials and equipment as detailed in each section.
- B. The Contractor shall verify that all equipment submitted can be delivered and installed within the time constraints of the construction period.
- C. Include the manufacturer, type, style, catalog number, complete specification, certified dimensions, and description of physical appearance for each item and option submitted. Reproduction of catalog data sheets shall be clean and legible to show all details, including gauge of metal used.
- D. Include only information on exact equipment to be installed, not general catalogs of the manufacturer. Where sheets show proposed equipment as well as other equipment, identify proposed equipment with rubber stamp arrow or similar concise method.
- E. Submit with each copy a transmittal letter verifying that all included equipment submittals have been carefully considered for quality, dimensions, function, and have been coordinated with the Drawings and Specifications. Guarantee that proposed materials will meet or exceed the quality and function of those specified.
- F. Include wire run and connection diagrams for all signal and/or low voltage systems, including floor plans.
- G. Submittal Review: The submittal review process is a means to determine quality control. The action noted to be taken (or where conflicts with the contract documents are not noted) shall not be interpreted by the Contractor as automatic "change orders." Approval of the data for substitution and shop drawings shall not eliminate the Contractor's responsibility for compliance with Drawings or Specifications, nor shall it eliminate the responsibility for freedom from errors of any sort in the data discovered prior to or after the review process. Deviations, discrepancies, and conflicts between the submittals and the Contract Documents shall be called to the Architect's attention in writing at the time of transmittal of the data.

- H. Unless otherwise directed by Division 1, submittal data shall be in a 3-ring plastic binder with a clear plastic sleeve and a project identification sheet inserted. Arrange submittals numerically with specification sections identified on divider tabs. All required sections shall be submitted at one time.

#### 1.06 PRODUCT SUBSTITUTION

- A. Material other than those specified may be approved for this project providing a written request is submitted to the Architect prior to bid in accordance with Instructions to Bidders. Requests shall include complete specifications, dimensions, manufacturer and catalog number for each item for which approval is desired. If, in the opinion of the Architect, the material is not complete or if it is not an acceptable substitute, he may reject it. The Architect's evaluation will be based solely on the material submitted.

#### 1.07 CHANGE ORDERS

- A. All supplemental cost proposals by the Contractor shall be accompanied by a complete itemized breakdown of labor and materials without exception. At the Architect's request, the Contractor's estimating sheets for the supplemental cost proposals shall be made available to the Architect. Labor must be separated and allocated for each item of work.

#### 1.08 RECORD DOCUMENTS

- A. Maintain a set of record drawings as directed in Division 1.
- B. Keep Drawings clean, undamaged, and up to date.
- C. Record and accurately indicate the following:
  - 1. Depths, sizes, and locations of all buried and concealed conduits/cables.
  - 2. Changes, additions, and revisions due to change orders, addenda, obstructions, etc. Eradicate extraneous information.
- D. Make Drawings available when requested by Architect for review.
- E. Submit as part of the required Project Closeout documents as indicated in Division 1.
- F. Use standards set in contract documents. Computer-aided design drafting (CADD) shall be used to complete project record drawings. Note field modifications, all addenda and change order items on project record drawings. If deficiencies are found in either the quality or the accuracy of the drawings, they will be returned unapproved. Additional review of subsequent submissions shall be at the Contractor's expense.
- G. Systems Manual: Submit separate Systems Manual [30] days prior to scheduling the required Instruction Period. The Systems Manual shall be a hard copy binder with fold out full size drawings, and a CD with all data in electronic format. The Document shall contain at minimum the following:
  - 1. Permit/Construction/Design Drawings.
  - 2. Contractor As-Built Drawings.
  - 3. A final version of the Basis of Design Document for LEED or Design Build projects.

4. Single line diagrams for all systems or components that require regular owner adjustment.
5. As-Built Sequence of Operations, Control Drawings, and Original Set Points for all equipment requiring contractor programming or set up, including but not limited to;
  - a. Lighting Control Systems.
  - b. HVAC DDC systems.
  - c. HVAC Equipment.
  - d. Plumbing/Pump systems.
  - e. Emergency Power systems.
  - f. All systems specifically required to be Commissioned.
  - g. Minimum set point data to include
    - 1) Seasonal System Adjustments
    - 2) Normal settings for thermostats, fans, VFDs and other motor switching devices.
    - 3) Normal Valve Settings.
    - 4) Original settings for time clocks, schedules, and Lighting Control Panels.
    - 5) Operating instructions for integrated building systems.
    - 6) Programing instructions.
    - 7) Recommended schedule of maintenance requirements and frequency.
    - 8) Recommended schedule for retesting of commissioned systems with blank test forms from the original commissioning plan.
    - 9) Recommended schedule for calibrating sensors and actuators.
    - 10) Emergency measures and procedures for systems failures.

#### 1.09 OPERATING AND MAINTENANCE DATA

- A. Upon completion of Contract and after no further action is noted as being required on catalog data submitted for review, submit multiple sets of Operating and Maintenance Manuals for inclusion in Owner's Maintenance Brochure as specified in Division 1. Operation and maintenance manuals shall include descriptive and technical data, maintenance and operation procedures, wiring diagrams, spare parts lists, service representatives, supplier for replacement parts, etc. Bind each set of Operating and Maintenance Manuals in 3-ring, vinyl or canvas covered, loose leaf binders organized with index and thumb-tab marker for each classification of equipment or data.

#### 1.10 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. At the completion of the project, at a time scheduled by the Owner, assemble key mechanics, subcontractors, vendors, factory representatives and similar personnel required to explain all facets of maintenance and operation of the installed system to the Owner's personnel. Instructions shall include actual operation of systems and methods of maintenance.

#### 1.11 ALTERNATE BIDS

- A. Refer to Division 1 for possible effect upon Work of this Division.

#### 1.12 WARRANTY

- A. Furnish, prior to application for final payment, three copies of written and signed guarantee effective a period of one year from date of completion and acceptance of entire project; agree to correct, repair and/or replace defective materials and/or equipment or the results of defective workmanship without additional expense to the Owner. Where no response satisfactory to the Owner has occurred within three working days from the written report of a warranty covered defect, the Contractor shall agree to pay for the cost of repair of the reported defect by a Contractor of the Owner's choice.
- B. Where the manufacturer's guarantee exceeds one year, the longer guarantee shall govern and include the Contractor's labor.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. All electrical products installed in this project shall be listed by Underwriters Laboratories, Inc., or be approved in writing by the local inspection authority as required by governing codes and ordinances.
- B. All material shall be new and bear manufacturer's name, model number, electrical characteristics and other identification, and shall be the standard product of manufacturer regularly engaged in production of similar material.
- C. All materials shall be of manufacturer's latest design, and of the best quality. The materials shall be manufactured in accordance with applicable standards listed under Quality Assurance.

### 2.02 ACCESS PANELS

- A. Provide panels of adequate size for equipment requiring service and installed above plaster or gypsum board ceilings, behind walls or in furring. Furnish complete with correct frame for type of building construction involved. Size, number and location of access panels is not necessarily shown on Drawings. Use no panel smaller than 12" x 12" for simple manual access, nor smaller than 16" x 20" where personnel must pass through. Milcor Style A, K, L, or M panels or equivalent Bilco or Potter-Roemer as required by construction. Access panels shall maintain ceiling fire rating.

### 2.03 PAINTING

- A. The work of this Division includes painting of the electrical items. All exposed conduits, boxes, surface raceways, etc. shall be painted per the Architect's direction. See Division 9 for additional painting requirements.

### 2.04 FIRE RATINGS

- A. Electrical items (light fixtures, boxes, etc.) recessed into fire rated walls or ceilings shall be alcoved in gypboard enclosures or be UL listed to maintain the fire rating.

## PART 3 - EXECUTION

## 3.01 LAYOUT AND COORDINATION

- A. The Contractor shall inspect the job site prior to bidding and become familiar with existing conditions which will affect his work. The Drawings are diagrammatic indicating approximate location of outlets, lighting fixtures, electrical equipment, etc. Consult the Architectural, Structural and Mechanical Drawings to avoid conflicts with equipment, structural members, etc. When required, make all deviations from Drawings to make the work conform to the building as constructed, and to related work of others. Minor relocations ordered prior to installation may be made without added cost to the Owner.
- B. Obvious omissions from Drawings or Specifications or differences between Drawings and Specifications shall be called to the Architect's attention at least ten (10) days prior to the bid date for clarification. Failure to do so will be construed as the willingness of this Contractor to supply all necessary materials and labor required for the proper completion of this work in a manner approved by the Architect.
- C. Call to the attention of the Architect any error, conflict or discrepancy in Drawings and/or Specifications. Do not proceed with any questionable items of work until clarification of same has been made.
- D. Supplementary details and plans may be supplied as required and they will become a part of the Contract Documents.
- E. Work under this Division shall be conducted in a manner to cooperate with all other trades for proper installation of all items of equipment.
- F. Coordination of work with other crafts employed on the project is mandatory. Arrange work to reduce interruption of existing services to minimum. When interruptions are unavoidable, consult Architect and utilities involved and agree in writing, with copy to the Architect, upon a mutually satisfactory time and duration.
- G. Verify the physical dimensions of each item of electrical equipment to fit the available space and promptly notify the Architect prior to roughing-in if conflicts appear. Coordination of equipment to fit the available space and the access routes through the construction shall be the Contractor's liability.
- H. Locations of items shown on the Drawings as existing are partially based on record and other drawings which may contain errors. The Contractor shall verify the correctness of the information shown prior to rough-in or demolition and notify the Architect of any discrepancies.
- I. Coordinate all work and trim with carpet installers. Provide carpet plates on all carpet surfaces, complete as required.
- J. Install equipment such that code-required working clearances are maintained, and allow clearances for future maintenance.
- K. Coordinate installation of electrical conduit, boxes, fittings, anchors, and miscellaneous items to be concealed in precast concrete assemblies.



## 3.02 UTILITY COORDINATION

- A. Utility Coordination: Coordinate all aspects of the incoming electrical, telephone and other utility services indicated with the city engineer, serving utility, and the off-street improvements contractor. Requirements of the utility company which exceed the provisions made on the Drawings or covered by these Specifications shall take precedence. Provisions made on the Drawings or Specifications in excess of the utility company's requirements shall take precedence. No additional compensation will be allowed the Contractor for connection fees or additional work or equipment not covered in the Drawings or Specifications which are a result of policies of the serving utilities.
- B. The Contractor shall contact the serving utility representatives and verify if any charges will be rendered against this project. These charges, if any, shall be included within the basic bid figure.
1. The utility representative is Clark Public Utilities :
  2. The telephone company representative is TBD :

## 3.03 EXCAVATING AND BACKFILL

- A. Provide trenching, backfilling, compaction, repaving or other site restoration as required by the work done in this Division. Minimum trench depth shall be 36" unless otherwise noted. Install 6" wide red vinyl tape with lettering "Caution: Buried Electric Line Below" 18" above all buried electric lines in this contract.
- B. Excavating and backfilling required for installation of electrical work shall be performed in accordance with requirements specified in Division 31. Backfill in excavations outside of building may be excavated material from site containing no rocks over 3/4" in diameter.
- C. Provide all necessary backfill materials, whether from site excavations or from off-site borrows, to completely fill excavations. Coordinate patching of all asphalt or concrete surfaces disturbed by this work with the Owner.
- D. Bored Crossings: Casing shall be smooth steel pipe fabricated in sections for welded joints, of size sufficiently large to provide adequate working space to properly install conduits, continuous butt welded at joints for rigid, watertight encasement, minimum thickness of 0.188" for casing under 14" diameter, and 0.281" for casings 14" and larger diameter.

## 3.04 PROTECTION OF WORK

- A. Protect electrical work, wire and cable, materials and equipment installed under this Division against damage by other trades, weather conditions or any other causes. Equipment found damaged or in other than new condition will be rejected as defective.
- B. Switchgear, panels, light fixtures and electrical equipment shall be kept covered or closed to exclude moisture, dust, dirt, plaster, cement, or paint and shall be free of all contamination before acceptance. Enclosures and trims shall be in new condition, free of rust, scratches or other finish defects. Properly refinish in a manner acceptable to the Architect if damaged.

- C. Including products of other Sections, clean, repair and touch-up or replace when directed, products which have been soiled, discolored or damaged.
- D. Provide for dehumidification of equipment during construction when directed by Architect.
- E. Remove debris from project site upon completion or sooner if directed.

### 3.05 GENERAL INSTALLATION METHODS

- A. Provide raceways and conduits for all electrical system wiring as specified herein. Class II or III systems wiring installed per Article 725 of NEC will be required to be installed in raceway unless otherwise indicated. When open wiring is permitted, raceways will be required in insulated walls and in other inaccessible areas. Low voltage wiring installed in return air plenums shall utilize plenum rated cable.
- B. The extent of the branch circuiting and control wiring shown shall not be changed.
- C. Cross or hash marks on power and lighting conduit runs indicate quantity of No. 12 minimum copper branch circuit conductors unless otherwise noted. Where such marks do not appear, provide conductors as required to provide an operable system, sized per local codes.
- D. Repair surfaces damaged during installation to match adjacent undisturbed areas. Surface preparation, including cleaning and priming, shall be in accordance with the paint manufacturer's requirements.
- E. Adjacent panelboards, component cabinets, terminal cabinets, trench duct, and wire gutter exposed in finished areas shall have matching trim and finish.
- F. In general, the mounting heights shall be as noted on the Drawings or as listed below. Where no heights are indicated, request clarification from the Architect. Consult the Architectural, Structural, and Mechanical Drawings to avoid conflicts prior to roughing in. All dimensions are to the center of the device above finished floor unless specified otherwise. Lighting dimensions are to the bottom of suspended fixtures; mount panelboards 72" to top handle; mount devices above counters, 12" above counter or 4-1/2" above backsplash, whichever is greater; and receptacles in unfinished areas 48".
- G. All raceways and wiring shall be concealed where possible. All wiring devices, recessed light fixtures, etc., shall be flush mounted unless otherwise noted.
- H. Relays, panels, cabinets and equipment shall be level and plumb and installed parallel with structural building lines. All equipment and enclosures shall be suitable for the environmental conditions in which they will operate.
- I. The Drawings do not indicate all items necessary. Provide associated equipment, materials, and labor as required for complete and operable systems.

### 3.06 CUTTING AND PATCHING

- A. Under no conditions are beams, girders, footings or columns to be cut for electrical items unless so shown on Drawings or written approval obtained from the Architect.
- B. Cutting, patching and repairing for the proper installation and completion of the work specified, including plastering, gypsum board, masonry work, concrete work, carpentry work and painting shall be performed by workers skilled in their respective trades.
- C. Follow requirements specified in Division 1.

### 3.07 SLEEVES AND CHASES

- A. Provide necessary rigid conduit sleeves, openings and chases where conduits or cables are required to pass through floors, ceilings or walls. Seal all openings around conduits against leaks and in a manner to maintain the fire rating of the structure penetrated. Prevent unnecessary cutting in connection with the finished work. Make all repairs and seals in a manner acceptable to the Architect.

### 3.08 NOISE CONTROL

- A. The entire electrical system apparatus shall operate at full capacity without objectionable noise or vibration.
- B. Outlet boxes at opposite sides of partitions shall not be placed back-to-back, nor shall straight-through boxes be employed, except where specifically permitted on the Drawings by note, to minimize transmission of noise between occupied spaces.
- C. Contactors, transformers, starters, and similar noise-producing devices shall not be placed on walls which are common to occupied spaces unless specifically called for on the Drawings. Where such devices must be mounted on walls common to occupied spaces, they shall be shock mounted or isolated in such a manner as to effectively prevent the transmission of their inherent noise to the occupied space.
- D. Ballasts, contactors, starters, transformers, and like equipment which are found to be noticeably noisier than other similar equipment on the project will be deemed defective and shall be replaced.

### 3.09 EQUIPMENT CONNECTIONS

- A. Provide complete electrical connections for all items of equipment requiring such connections, including incidental wiring, materials, devices and labor necessary for a finished working installation.
- B. Verify the rough-in and wiring requirements for all equipment provided under other Divisions of the work and requiring electrical connections with equipment supplier and installer prior to rough-in. Check the voltage and phase of each item of equipment before connecting. Motor connections shall be made for the proper direction of rotation. Pump motors shall not be test run until liquid is in the system and proper lubrication to all bearings in unit is checked. Minimum size flex for mechanical equipment shall be 1/2". Exposed motor wiring shall be jacketed metallic flex.

- C. Conduit, wire and circuit breaker sizes for mechanical equipment and equipment furnished under other Divisions are based on the equipment ratings of one manufacturer. The equipment actually furnished may be of a different brand with different electrical characteristics. Conduit, wire and circuit breakers shall not be ordered or installed until exact electrical requirements are obtained. Responsibility for this coordination shall rest with the Contractor.

### 3.10 TESTS

- A. Complete each system as shown or specified herein and place in operation except where only roughing-in or partial systems are called for. Each system shall be tested and left in proper operation free of faults, shorts, or unintentional grounds.
- B. After the interior wiring system installation is completed, and at such time as the Owner may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of the Specification. The test shall be performed in the presence of the Owner or an authorized representative. The Contractor shall furnish all instruments and personnel required for the tests, and the Owner will furnish the necessary electric power. The Contractor shall submit in writing to the Owner upon completion of the project the measured ground resistance of each ground rod, indicating the location of the rod, the resistance, and the soil conditions at the time the measurements were made.

END OF SECTION

## SECTION 26 05 19 - ELECTRICAL POWER CONDUCTORS AND CABLES

## PART 1 - GENERAL

## 1.01 DESCRIPTION

- A. Provide all conductors, cables, connectors, lugs, cable ties, and terminations for all systems.

## 1.02 QUALITY ASSURANCE

- A. All conductors shall be Underwriters Laboratories, Inc., listed and comply with Fed. Spec. J-C-30B and UL 83. Materials omitted here but necessary to complete the work are to be of comparable quality.

## 1.03 PRODUCT DELIVERY, STORAGE &amp; HANDLING

- A. Deliver conductors and cables in complete coils with UL label and bearing manufacturer's name, wire size, and type of insulation.
- B. Store and handle materials so as not to subject them to corrosion or mechanical damage and in a manner to prevent damage from environment and construction operation.
- C. Deliver conductors No. 10 and smaller in manufacturer's original unopened and undamaged cartons with labels legible and intact.

## 1.04 SUBMITTAL AND RECORD DOCUMENTATION

- A. None required.

## PART 2 - PRODUCTS

## 2.01 CONDUCTORS

- A. Conductors No. 10 AWG and smaller may be soft-drawn, stranded, or solid copper. Conductors larger than No. 10 AWG shall be stranded, soft-drawn copper.
- B. Insulation for new conductors installed in raceways shall be "THWN" for conductors No. 8 AWG or smaller, and "THWN" or "THHN" for conductors No. 6 AWG or larger, or as noted.
- C. Where adverse conductor exposure exists, code-approved insulation suitable for the conditions encountered shall be used unless shown otherwise on the Drawings.
- D. All wire and cable for feeder circuits shall conform to the latest requirements of the current edition of the NEC and shall meet all ASTM Specifications. Wire and cable shall be new and have wire size, grade of insulation, voltage, and manufacturer's name permanently marked on outer covering at regular intervals.

- E. Sizes shall not be less than indicated. Branch circuit conductors shall not be smaller than No. 12 AWG. Class I remote control and signal circuit conductors shall not be less than No. 14 AWG. Class 2 low energy remote control and signal circuit conductors shall not be less than No. 18 AWG.
- F. All insulation shall be rated 600 volts unless noted otherwise.
- G. Acceptable Manufacturers: General Electric, Hatfield, Anaconda, Rome Cable, Essex, Belden, West Penn, or approved.

## 2.02 SPLICES AND TERMINATIONS

- A. All connectors shall be solderless pressure type per Fed. Spec. W-S-610, properly taped. All taped joints shall be with plastic tape, "Scotch 33," applied in half-lap layers without stretching to deform.
- B. Splices shall utilize Scotch "Hyflex" or "Ideal" wing nut connector installed properly. Splices for No. 8 and larger wires shall be made with tin or silver plated copper compression sleeves.
- C. Splices made in handholes and manholes, or underground splices, shall be made water tight with epoxy resin-type splicing kits.

## PART 3 - EXECUTION

### 3.01 CONDUCTORS

- A. Insulation shall be removed with a stripping tool designated specifically for that purpose. All conductors shall be left nick-free.
- B. UL listed pulling compounds may be used with the residue cleaned from the conductors and raceway entrances after the pull is made.
- C. Raceway shall be complete, clean and free of burrs before pulling conductors.
- D. Wire shall not be left extending out of exposed conduit stubs or incomplete raceways where subject to mechanical injury.
- E. Pulleys or blocks shall be used for alignment of the conductors when pulling. Pulling shall be in accordance with manufacturer's specifications regarding tensions, bending radii of the cable and compounds.
- F. Conductors shall be terminated as required.
- G. Conductor sizes for special systems shall be as recommended by the equipment manufacturer except as noted.
- H. Stranded conductors shall not be terminated with post and screw unless compression spade/ring lug is utilized.
- I. 120-volt homeruns over 80 feet in length shall be minimum #10 conductor.

### 3.02 LABELING

- A. Provide color coding of building wiring consistent throughout the work as listed herein, unless required otherwise by local code authority. Band feeder conductors not available in colors where clearly visible at each termination, tape or splice using two full wraps of 3/4" adhesive vinyl tape or equally visible color marking corresponding to the following table.

<u>Less than 250V between phases</u>	<u>251 to 600V btwn phases</u>
Phase A - Black	Phase A - Brown
Phase B - Red	Phase B - Orange
Phase C - Blue	Phase C - Yellow
Neutral - White	Neutral - Gray
Ground - Green	Ground - Green

- B. Switch legs, travelers, etc., to be consistent with the above phases to which they are connected or may be any other color distinctive from those listed above. Complex control circuits may utilize any combination of colors but the identification shall be by labels throughout. Labeling shall be accomplished by using computer-generated heat shrink labels suitable for the wire size used. In no case will hand lettering or wraparound labels be accepted.
- C. Phase color code to be consistent at all feeder terminations, A-B-C left to right or A-B-C top to bottom.
- D. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made.
- E. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking is not acceptable.

### 3.03 SPLICES AND TERMINATIONS

- A. Splices are to be made up completely promptly after wire installation. Single wire pigtails shall be provided for fixture and device connections. Wire nuts may be used for fixture wire connections to single wire circuit conductor pigtails.

### 3.04 CONNECTORS

- A. Control and special systems wires shall be terminated with a tool- applied, spade-flared lug when terminating at a screw connection.
- B. All screw and bolt-type connectors shall be made up tight and be retightened after an eight-hour period.
- C. All tool-applied compression connectors shall be applied per manufacturer's recommendations and physically checked for tightness.
- D. Check terminations in all panelboards, switchgear, motor control centers, etc., six months after completion of installation. Supply a confirming letter to the Owner at completion of test.

### 3.05 TESTS

- A. Perform insulation resistance tests on all feeders and circuits over 100 A, 480 volt and below, with a 1,000 volt megger. The written test report listing the results of the test to be included in the Operating and Maintenance Manuals. Equipment which may be damaged by this test shall be disconnected prior to the test.

END OF SECTION



## SECTION 26 05 20 - NONMETALLIC-SHEATHED CABLE

## PART 1 - GENERAL

## 1.01 DESCRIPTION

- A. Provide all nonmetallic-sheathed cables, supports, and terminations as indicated on the drawings and described herein, to provide a complete and operable system. It may only be used in Type R occupancies where allowed by the NEC and local codes. Refer to Architectural drawings for identification of occupancy types.

## 1.02 SUBMITTAL AND RECORD DOCUMENTATION

- A. Submit product data for cables and supports.

## PART 2 - PRODUCTS

## 2.01 MATERIALS

- A. Cable shall be type NMC (overall covering shall be flame retardant, moisture resistant, fungus resistant, and corrosion resistant) cable, and shall meet or exceed UL Standards 83 and 719. Conductors shall be annealed solid or stranded copper conductors No. 12 through No. 6 AWG, 600 volt, with color-coded insulation, rated at 90 deg C.
- B. Acceptable Manufacturers: Rome Cable or equal.

## PART 3 - EXECUTION

## 3.01 INSTALLATION

- A. Support horizontal and vertical cable 4-1/2 feet on center (maximum) and within 12" of boxes with approved cable staples, per the NEC.
- B. Support cable above accessible ceilings; do not rest cables on ceiling tiles.
- C. Cable shall be cut with manufacturer-approved devices.
- D. Splice conductors only in accessible junction boxes.
- E. Cable shall not be supported from or come into contact with mechanical ducts, water, sprinkler or gas piping; maintain 6-inch separation minimum.
- F. Provide junction box at all cable penetrations of wall, ceiling, or floor surfaces for equipment connections; cable shall not be run directly through finished surfaces.
- G. Voltage Drop: Conductors over 75 feet for 120-volt, for branch or individual circuit home runs from equipment connection, receptacle or lighting fixture shall be No. 10 AWG minimum.

- H. Provide junction box at transition from concealed to exposed wiring. Exposed wiring shall conform with Section 26 05 33 – Raceway and Boxes for Electrical Systems.
- I. Where cable penetrates fire-rated walls or floors, provide fire stop material with UL-listed fire rating equal to wall or floor rating.
- J. Provide junction box at transition from interior to exterior wiring. Exterior wiring shall conform to Section 26 05 33 – Raceway and Boxes for Electrical Systems.
- K. Protect shallow-installed cables with steel plates per the NEC.

END OF SECTION

## SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

## 1.01 DESCRIPTION

- A. Provide ground system as specified herein, as shown on the Drawings, and as required by NEC and other rules and regulations pertaining to grounding.

## 1.02 SUBMITTAL AND RECORD DOCUMENTATION

- A. None required.

## PART 2 - PRODUCTS

## 2.01 GROUND CONDUCTORS

- A. Equipment or grounding conductors shall be soft drawn copper, stranded per ASTM B8 and, if insulated, shall have green insulation.

## 2.02 GROUNDING BUSHINGS/WEDGES

- A. Sufficient ampacity with grounding conductor set screw connection.

## 2.03 CONNECTOR

- A. Cast, set screw or bolted type.

## 2.04 GROUND RODS

- A. Copper-clad steel, not less than 3/4" in diameter, 8' long, driven full length into the earth.

## PART 3 - EXECUTION

## 3.01 INSTALLATION

- A. All grounding conductors shall be sized in accordance with Article 250, Tables 250.66 and 250.122 of the NEC.
- B. Except where specifically indicated otherwise, all exposed non-current-carrying metallic parts of electrical equipment, metallic raceway systems, and neutral conductor of the wiring system shall be grounded.
- C. The ground connection shall be made at the main service equipment and shall be extended to the point of entrance of the metallic water service. Connection to the water pipe shall be made by a suitable ground clamp. If flanged pipes are encountered, connection shall be made with the lug bolted to the street side of the flange connection.

- D. Where the metallic water service is used, it shall be grounded as described by Article 250.53 of the NEC.
- E. Generally, all supplemental grounding electrodes shall be ground rods.
- F. All ground wire connections below finished grade, cast in concrete, or bonding solid wire shall be exothermically welded.
- G. Where there is no metallic water service to the building, ground connections shall be made to driven ground rods on the exterior of the building.
- H. The maximum resistance measured in accordance with IEEE Standard 142 of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, additional rods shall be installed not less than 6' on centers, or if sectional-type rods are used, additional sections may be coupled and driven with the first rod. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Engineer shall be notified immediately.
- I. Grounding conductor connectors shall be made up tight and located for future servicing and to ensure low impedance.
- J. The Contractor shall submit in writing to the Owner upon completion of the project the measured ground resistance of each ground rod, indicating the location of the rod and the resistance and the soil conditions at the time the measurements were made.
- K. Where new circuits are to be served by existing panels with no ground bus, provide supplemental copper ground bus in panel.

END OF SECTION

## SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

## 1.01 DESCRIPTION

- A. Provide all electrical equipment and wiring with adequate supports of specified type required for a complete installation.

## 1.02 SUBMITTAL AND RECORD DOCUMENTATION

- A. Submit shop drawings indicating details of fabricated products and materials.

## PART 2 - PRODUCTS

## 2.01 FASTENERS

- A. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring steel tension clamps on steel work; for new concrete installation use cast-in-concrete inserts. Kindorf D-255 or approved.
- B. Hammer-driven and trigger-fired anchors may be used only after obtaining specific written authorization from the Architect.

## 2.02 OUTLET BOX SUPPORTS

- A. Wood Stud Walls: Adjustable bar hangers with "C" channel cross section Steel City 6010 series, or approved, or mounted on solid blocking. 4-inch square boxes adjacent to wood studs may be side nailed and back braced with Steel City No. 50 box brace.
- B. Light steel construction, bar hangers with 1-inch long studs between metal studs or metal stud "C" brackets snapped on and tab-locked to metal studs.
- C. Concrete or masonry walls where boxes are not cast in place. Flush anchors or concrete inserts.
- D. Flush Ceiling Outlets: Steel City 6010 series or equal bar hangers.

## 2.03 CONDUIT SUPPORTS

- A. One Hole Malleable Straps: Steel City, Appleton, T&B, Diamond, Raco, or approved.
- B. Conduit Clips: Caddy, Raco, or approved.
- C. Nail-Up Straps: 1/2" through 1", Raco 2252, 2253, 2254, or approved.

- D. Adjustable Hangers for Conduits 1-1/2" and Larger: Steel City C-149 with threaded steel rod of proper size.
- E. Adjustable trapeze hangers to support groups of parallel conduits; Steel City B-905 steel channel, H-119 square washer, C-105 strap, threaded rod. Components of Unistrut, Globe Strut, Harvey Alstrut, Kindorf, Thomas & Betts, or approved.

#### 2.04 HANGER ROD ATTACHMENTS

- A. Side Beam Connector, Kindorf E-244; 90 degree fitting, Kindorf B-916; clamp type anchor clips Kindorf Type "C," Unistrut P2675 or approved, spot type concrete insert Kindorf B-255 with "Galv-Krom" finish.

#### 2.05 SUPPORT CHANNELS

- A. Conduit: Kindorf B-905 with Galv-Krom finish, and C-105 single bolt channel pipe straps.
- B. Lighting: Kindorf B-900 with G-969 closure strip and G-977 swing connector.
- C. Recessed in Concrete: Kindorf D-980 with D-982 anchored end caps and D-983 joiner clips.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- A. Every fastening device and support for electrical equipment (includes fixtures, panels, outlets, conduits, and cabinets) shall be capable of sustaining not less than four times the ultimate weight of the object or objects. Fasten support to the building or a building structural member.
- B. Provide independent supports to the building or building structural member for electrical fixtures, materials, or equipment installed in or on ceiling, walls, or in void spaces and/or over the furred or suspended ceilings. Chain or additional ceiling wires may be used for light fixture supports.
- C. Other crafts' fastening devices shall not be used for the supporting means of electrical, equipment, materials, or fixtures.
- D. Supports and/or fastening devices shall not be used to support more than one particular item.
- E. Vertical support members for equipment and fixtures shall be straight and parallel to building walls.
- F. Examine all equipment locations to determine type of supports required.
- G. Raceways or pipe straps shall not be welded to steel structures.
- H. Holes cut to a depth of more than 1-1/2" in reinforced concrete beams or to a depth of more than 3/4" in concrete joists shall avoid cutting the main reinforcing bars. Holes not used shall be filled.

## 3.02 BOXES

- A. Boxes and pendants for surface-mounted fixtures on suspended ceilings shall be supported independently of the ceiling supports.
- B. In open overhead spaces, cast metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers.
- C. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved fastener not more than 24" from the box.

## 3.03 RACEWAYS

- A. Support conduits within 18" of outlets, boxes, panels, cabinets, couplings, elbows, and deflections. Maximum distance between supports shall not exceed ten (10) foot spacing.
- B. Conduit up to and including 1" EMT may be supported from ceiling fixture wires by conduit clips or other approved devices only with written approval of the installer of the ceiling support system. All other conduit runs shall be secured to the structure by two-hole straps or supported on Kindorf or Unistrut hangers. Wire will not be permitted for supporting conduit. All visible conduit runs will be parallel to the building structural lines.
- C. Anchor conduit installed in poured concrete to the steel reinforcing with No. 14 black iron wire.
- D. In partitions of light steel construction, sheet metal screws may be used, and bar hangers may be attached with saddle-suspended ceiling construction only. Lighting system branch circuit raceways shall be fastened to the ceiling supports.
- E. Support suspended feeder conduits by metal ring or trapeze hangers with threaded steel rods. Wire ties to prevent displacement, using not less than No. 14 iron wire, may be used only for concealed runs in concrete for conduit up to 1-1/4".
- F. At main distribution and surface mounted branch panels and cabinets where conduit exits from the top, provide support channels on wall 24" above panel and at 6'-0" intervals from there on for support of conduits.

END OF SECTION

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide all raceways, fittings, and boxes of specified type required for complete project. Install all systems in raceways unless specifically noted otherwise. Provide all outlet boxes, junction boxes, pull boxes and special boxes required for pulling of wires, making connections, and mounting of devices or fixtures.

1.02 QUALITY ASSURANCE

- A. Underwriters Laboratories, Inc., listed and NEC approved
- B. All boxes shall be Underwriters Laboratories, Inc., listed. Where special fabrication is required, the work shall be performed by a listed facility in accordance with UL 50, and all products of manufacture shall bear a label. Outlet and junction boxes shall be sized in accordance with NEC requirements for "THHN" wire or as noted on Drawings.

1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver raceways with Underwriters Laboratories, Inc., label and bearing manufacturer's name on each length.
- B. Deliver fittings in manufacturer's original unopened and undamaged packages with labels legible and intact.

1.04 APPLICATION

- A. Areas of use:

Underground	PVC
Within poured Concrete (except slab-on grade) or CMU	GRC, IMC, PVC
Dry concealed locations	GRC, IMC, EMT
Wet or Dry exposed locations, subject to damage	GRC, IMC
Dry exposed locations, not subject to damage	GRC, IMC, EMT
Hazardous Class I or II	GRC, IMC

- B. Underground conduit shall be minimum 3/4" trade size. PVC shall not be used inside building. Unless otherwise approved, all conduits shall be installed under reinforcing steel.
- C. Where the contractor elects to utilize PVC in lieu of GRC, the contractor shall provide supplemental ground bus in terminating switch and panelboards, and green ground wire in conduit according to code rules.



- D. For the purposes of this section, poured concrete slabs on grade and under-the-building slabs are not classified as dry locations.
- E. Flexible metal conduit will be permitted only where flexibility is necessary. Exceptions are connections to recessed light fixtures. Flexible metal conduit shall be used for connection to all equipment subject to movement or vibration such as motors, transformers, etc. Liquid-tight flexible metal conduit shall be used when moisture may be present and for exposed motor and equipment connections.
- F. Surface raceway may be used only where specifically called for on the Drawings or in the Specifications.
- G. Aluminum conduit is not permitted.

#### 1.05 SUBMITTAL AND RECORD DOCUMENTATION

- A. Submit product data for surface raceway and wireway.
- B. Submit product data for floor boxes. Submit shop drawings for nonstandard boxes, enclosures, and cabinets. Include layout drawings showing components and wiring.

### PART 2 - PRODUCTS

#### 2.01 ACCEPTABLE MANUFACTURERS

- A. Allied Tube & Conduit, Western Tube & Conduit, Triangle, Bridgeport, AFC, Carlon, Western Plastics, Alflex, or approved substitute. Wiremold, Walker, or approved substitute. Raco, Thomas & Betts, or approved substitute.

#### 2.02 CONDUITS

- A. Galvanized Rigid Conduit (GRC) shall be hot-dip zinc, galvanized inside and out, mild steel pipe manufactured in accordance with UL-6 and ANSI C80.1. All threads shall be galvanized after cutting.
- B. Electrical Metallic Tubing (EMT) shall be steel only and shall comply with UL-797 and ANSI C80.3. Exterior shall be hot-dip zinc galvanized and interior protected by a corrosion-resistant lubricating coating.
- C. Intermediate Metallic Conduit (IMC) shall comply with UL-1242 and ANSI C80.6. Exterior shall be hot-dip zinc galvanized and interior protected by a corrosion-resistant lubricating coating.
- D. Rigid non-metallic conduit (PVC) polyvinyl chloride shall be schedule 40 unless otherwise noted, and shall comply with UL-651 and NEMA TC 2.
- E. Surface raceway shall utilize snap-in cover and fittings as recommended by the manufacturer and shall comply with UL 5 standard. Material and size shall be as indicated on the Drawings.

- F. Flexible metal conduit shall be steel and comply with UL 1 and ANSI standards. Liquid-tight flexible metal conduit shall comply with UL 360 and ANSI standards.

### 2.03 WIREWAYS

- A. Gutters: Steel, painted, square in cross section, preformed knockouts on standard spacing, screw cover, suitable for environment.
- B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.
- C. Exterior wireways and fittings/accessories shall be stainless steel.

### 2.04 FITTINGS

- A. GRC and IMC shall be coupled and terminated with threaded fittings. Ends shall be bushed with insulating bushings equal to T&B 1220 or 1230 series.
- B. Connectors and couplings for EMT shall be steel concrete tight compression type or set screw type with insulated throats on connectors. Indent type connectors shall not be used.
- C. Conduits piercing a building waterproof membrane shall be provided with O-Z type FSR fittings.
- D. Flexible metal conduit shall utilize screw-in type connectors. Couplings and set-screw type connectors are not permitted.
- E. Seal-offs with filler fiber, compound, large removable cover. All components shall be of the same manufacturer.
- F. Expansion Couplings:
  - 1. Exposed Conduit Runs: Expansion couplings shall be weatherproof with external bonding jumper, providing at least 4" longitudinal movement with bushed conduit ends.
  - 2. Concealed Conduit Runs: Expansion couplings shall be water tight with an internal bonding jumper and neoprene construction. The fitting shall allow 3/4" movement in any direction or deflection of 30 degrees from normal.
- G. Locknuts shall be galvanized steel.

### 2.05 BOXES

- A. Boxes for use with raceway systems shall not be less than 4" square and 1-1/2" deep except where shallower boxes required by structural conditions are approved.
- B. Flush and Concealed Outlet Boxes: Galvanized stamped steel with screw ears, knock-out plugs, mounting holes, fixture studs if required.

- C. Surface Outlet Boxes: Galvanized stamped steel same as above for use on ceilings and walls above 14 feet.
- D. Boxes shall be of the cast-metal hub type when located in normally wet locations and when surface mounted on outside of exterior surfaces.
- E. Boxes installed for concealed wiring shall be provided with suitable extension rings or plastic covers as required.
- F. Cast-metal boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed.
- G. Provide boxes suitable for the intended environment and sized as required to accommodate the equipment within. Exterior boxes shall be stainless steel.
- H. Pull boxes of not less than the minimum size required by the National Electrical Code shall be constructed of code-gauge aluminum or galvanized sheet steel except where cast-metal boxes are required in locations specified above. Boxes shall be furnished with screw-fastener covers. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Ends of metal conduits shall be reamed and left free of burrs.
- B. Provide pull boxes or vaults where shown or required to limit the number of bends in any conduit to not more than three 90 degree bends, or to ease pulling tension. Use boxes of code-required size with removable covers, installed so that covers will be accessible after work is completed.
- C. Conceal all wiring in finished spaces so far as practicable. Exposed conduit shall be used only in unfinished spaces.
- D. Exposed raceways shall be parallel or at right angles to structural lines, and shall be neatly offset into boxes. Exposed raceways shall follow existing exposed piping/ductwork/conduit paths as far as practicable.
- E. Conduit stubbed from a concrete slab or wall to serve an outlet mounted on a table or to supply a machine shall have a rigid conduit coupling flush with the surface of the slab. Provide plug where conduit is to be used in future.
- F. Keep conduit and raceway closed with suitable plugs or caps during construction to prevent entrance of dirt, moisture, concrete or foreign objects. Raceways shall be clean and dry before installation of wire and at the time of acceptance.
- G. Remove all foreign matter from raceways and pull mandrel through conduits larger than 1-1/2" prior to installing conductors.

- H. Where no conduit size is noted on the Drawings, conduit may be the minimum code permitted size for the quantity of type THHN conductors installed, but in no case smaller than 1/2" trade diameter. Conductor quantities indicated in conduits do not include ground wire unless otherwise noted. Adjust conduit sizes accordingly.
- I. Where the contractor elects to combine branch circuit runs shown as separate runs on the Drawings, provide a minimum 3/4" conduit or increase raceway size to provide a minimum of 25 percent spare capacity for future conductors. Feeder runs shall not be combined.
- J. All conduits installed in concrete construction, underground, or under the building slab shall be minimum 3/4", unless otherwise noted.
- K. Assemble, glue and seal PVC conduit in straight lengths prior to installation in trench.
- L. Seal-offs shall be installed in all conduits which route from warm areas into refrigerated areas.
- M. Install PVC conduit in accordance with manufacturer's instructions. Cut the conduit ends square and apply an approved solvent to clean the joint. Apply an approved cement and allow to set 24 hours before installing conductors.
- N. Conduits shall be fastened to all sheet metal boxes and cabinets with two locknuts where required by the National Electrical Code, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used.
- O. A pull wire shall be inserted into each empty raceway in which wiring is to be installed by others. The pull wire shall be of No. 15 AWG zinc-coated steel, or of plastic having not less than 200-pound tensile strength. Not less than 10" of slack shall be left at each end of the pull wire.
- P. Raceway shall not be installed under the fire pits of boilers and furnaces and shall be kept 6" away from parallel runs of flues, steam pipes and hot water pipes.
- Q. Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed.
- R. Expansion fittings complete with grounding jumpers shall be installed where raceways cross expansion joints, construction joints, sawed joints, and where shown.
- S. Where conduit is shown stubbed into a telephone, computer or communication terminal area, conduit shall be stubbed up 6" above floor or 12" below ceiling and terminated with insulating bushings.
- T. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate head room, working clearance, and access to both boxes and other equipment.
- U. The end of a conduit stub shall have an insulated bushing.

- V. Pack spaces around conduits with polyethylene backing rods and seal with polyurethane caulking to prevent entrance of moisture where conduits are installed in sleeves or block-outs penetrating partitions.
- W. Install intumescent material around ducts, conduits, etc., to prevent spread of smoke or fire where installed in sleeves or block-outs penetrating fire-rated barriers. An alternate method utilizing intumescent materials in caulk and/or putty form may be used.
- X. Outlet boxes shall be designed for the intended use. Flush outlet boxes shall be installed flush with finished surface lines.
- Y. Outlet boxes on flex connected fixtures shall be installed within five feet of conduit knock-out in fixture.
- Z. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate head room, working clearance, and access to both boxes and other equipment.

### 3.02 INSTALLING CONDUIT BELOW SLAB-ON-GRADE OR IN THE GROUND

- A. All electrical wiring below slab-on-grade shall be protected by a conduit system.
- B. No conduit system shall be installed horizontally within concrete slab-on-grade. For slab-on-grade construction, horizontal runs of rigid plastic shall be installed below the floor slab.
- C. Conduit passing vertically through slab-on-grades shall be coated rigid steel.
- D. Slope conduits away from terminal equipment; drain away from the building interior.
- E. Rigid steel or IMC conduits, metal boxes, and couplings installed below slab-on-grade or in the earth shall be field-wrapped with 0.010" pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory applied plastic resin, epoxy, or coal-tar coating system. Zinc coating may be omitted from rigid steel conduit, or IMC which has a factory-applied epoxy system. All joints shall be threaded, sealed and wrapped with tape to prevent entry of water. Use 20 mil pipe wrapping tape to cover wrench marks, field cuts, or abrasions to the outer factory installed anti-corrosion covering.
- F. Provide duct seal at ends of all underground and under-slab conduits.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Clearly and properly label the complete electrical system to indicate the loads served or the function of each item of equipment connected under this work.

1.02 SUBMITTAL AND RECORD DOCUMENTATION

- A. None required.

PART 2 - PRODUCTS

2.01 IDENTIFICATION MARKERS

- A. Unless otherwise specified, all identification nameplates shall be made of laminated three-ply plastic in accordance with Fed. Spec. L-P-387 equal to "Lamicoid." Nameplates shall be minimum 1/16" thick, with black outer layers and a white core, red outer ply for all emergency applications. Edges shall be chamfered.
- B. Provide identification nameplates for starters, switchboards, safety switches, panelboards, motor control centers, transformers, equipment (air handling units, exhaust fans, pumps, etc.), with a minimum of 1/4" high letters.
- C. Provide identification nameplates for control power transformers, control devices (relays, contactors, etc.), with a minimum of 1/8" high letters.
- D. Where switches control remote lighting, exhaust fans, or power outlets, or where switches in the same gang (two or more) serve different purposes, such as light, power, intercom, etc., or different areas, such as corridor and outlet, furnish engraved cover plates with 1/8" black letters indicating function of each switch or outlet.

PART 3 - EXECUTION

3.01 LABELING

- A. Major items of electrical equipment and major components shall be permanently marked with an identification nameplate to identify the equipment by type or function and specific unit number as shown on the Drawings.

- B. Provide typewritten branch panel schedules with protective clear, transparent covers accounting for every breaker installed. Use actual room designations assigned by name or number near completion of the work, and not the designation on the construction drawings. Minimum panel schedule width shall be 4" with 1/4" height allowed for each circuit line. Panel schedules shall be the type which install in a metal frame or pocket. Panel schedules shall be of the odd/even sequence (1-3-5-7-9... and 2-4-6-8-10...).
- C. Identify service entrance and distribution switchboards with engraved nameplate corresponding with the plans, mounted on the face of the switchboard. Identify each feeder, breaker, and switch with engraved nameplate corresponding with the plans.
- D. Identify branch panels with engraved nameplate corresponding with the main or subdistribution panel labeling, mounted on the face of the door. No brand labels or other markings shall be on the outside of the panels.
- E. Label all disconnect switches, relays, contactors, starters and time switches indicating voltage, amperage, power panel source, circuit number and equipment served with laminated plastic label.
- F. Nameplates shall be secured with screws or pop rivets. Adhesive-only fasteners shall not be permitted.

END OF SECTION

## SECTION 26 05 73 - ELECTRICAL POWER SYSTEM STUDIES

## PART 1 - GENERAL

## 1.01 RELATED DOCUMENTS

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

## 1.02 DESCRIPTION

- A. The electrical equipment manufacturer shall provide electrical power system studies for the project as specified herein.

## 1.03 SUBMITTAL AND RECORD DOCUMENTATION

- A. Submit five copies of the completed power system studies, bound and tabulated with table of contents and section & page numbers.

## PART 2 - PRODUCTS

## 2.01 SHORT-CIRCUIT ANALYSIS

- A. Calculation of the maximum rms symmetrical three-phase short-circuit current at each significant location in the electrical system shall be made using a digital computer and software.
- B. Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer-calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.
- C. A tabular computer printout shall be included which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.
- D. The study shall include a computer printout of input circuit data including 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.
- E. Include a computer printout identifying the maximum available short-circuit current in rms symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.
- F. The system one-line diagram shall be computer generated and shall clearly identify individual equipment buses, bus numbers/names used in the short-circuit analysis, cable and bus connections between equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.



- G. 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.
- H. The analysis shall be based upon the actual available three-phase short-circuit rms symmetrical current from the serving utility's system. Include in the report this value on utility letterhead.
- I. The Contractor shall be responsible for supplying actual conductor information (lengths, types, number per phase, etc.) and other pertinent equipment information (transformer sizes and impedances, generator sizes and sub-transient reactances, etc.) to the equipment manufacturer in a timely manner to allow the short-circuit analysis to be completed, reviewed, and modified as necessary prior to ordering of equipment.
- J. Any inadequacies shall be called to the attention of the Engineer and recommendations made for improvements as soon as they are identified.

## 2.02 EMERGENCY SYSTEM PROTECTIVE DEVICE TIME-CURRENT COORDINATION ANALYSIS

- A. The time-current coordination analysis shall be performed on the emergency system with the aid of a digital computer and software and shall include the determination of settings, ratings, or types for the overcurrent protective devices supplied, to comply with NEC 700 and/or 701.
- B. Where necessary, the Engineer shall be consulted regarding the appropriate compromises to be made between system protection and service continuity.
- C. A sufficient number of computer-generated 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.
- D. Computer printouts shall accompany the log-log plots and shall contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
- E. The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable overcurrent protective devices, the equipment where the device is located, and the device number corresponding to the device on the system one-line diagram.
- F. A computer-generated system 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.
- G. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for increasing system protection or device coordination.

- H. The Contractor shall be responsible for supplying actual equipment and system information to the equipment manufacturer in a timely manner to allow the protective device time-current coordination analysis to be completed, reviewed, and modified as necessary prior to ordering of equipment.
- I. Significant deficiencies in protection and/or coordination shall be called to the attention of the Engineer and recommendations made for improvements as soon as they are identified.

### 2.03 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- C. The Arc-Flash Hazard Analysis shall include all significant locations in 480 volt systems, and in all 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.
- D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of  $1.2 \text{ cal/cm}^2$ .
- E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices shall 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. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
- 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 and generators should be decremented as follows:
  - 1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.

2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- 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. Mis-coordination 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 calculation shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. 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.

#### 2.04 MANUFACTURERS/VENDORS

- A. The specified electrical power system studies shall be performed by the manufacturer(s) of the electrical distribution equipment.

### PART 3 - EXECUTION

#### 3.01 ARC FLASH WARNING LABELS

- A. The Contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. All labels shall be based on recommended overcurrent device settings and shall be provided after the results of the analysis have been presented to the Owner and after any system changes, upgrades or modifications have been incorporated in the system.
- C. The label shall include the following information, at a minimum:
  1. Location designation
  2. Nominal voltage
  3. Flash protection boundary
  4. Hazard risk category
  5. Incident energy
  6. Working distance
  7. Engineering report number, revision number and issue date.
- D. Labels shall be machine printed, with no field markings.

- E. Arc flash labels shall be provided in the following manner and all labels shall be based on the recommended overcurrent device settings.
  - 1. For each 480 volt and applicable 208 volt (or 240 volt) panelboard, one arc flash label shall be provided.
  - 2. For each motor control center, one arc flash label shall be provided.
  - 3. For each low voltage switchboard, one arc flash label shall be provided.
  - 4. For each switchgear, one arc flash label shall be provided.
  
- F. ARC Flash Training
  - 1. The Contractor of 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 training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.

END OF SECTION

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide lighting control equipment complete and operable as specified herein and as shown on the Drawings.

1.02 QUALITY ASSURANCE

- A. All lighting control equipment shall be UL and CUL listed and labeled and shall comply with the NEC.
- B. Comply with FCC Regulations of Part 15, Subpart J, for Class A.
- C. All equipment in this section to have a minimum 5 year warranty.

1.03 SUBMITTAL AND RECORD DOCUMENTATION

- A. Submit product data for lighting control equipment and systems components, including dimensions and data on features and components. Include elevation views of front panels of control and indicating devices. Include data on ratings.
- B. Submit wiring diagrams detailing specific systems tailored to this Project and differentiating between factory-installed and field-installed wiring.
- C. Submit maintenance data for lighting control equipment and systems components to include in the operation and maintenance manual specified in Division 1.

PART 2 - PRODUCTS

2.01 LINE-VOLTAGE OCCUPANCY SENSORS (AUTOMATIC WALL SWITCH)

- A. Sensor shall be capable of detecting presence in the control area by detecting infrared energy. Small movements shall be detected, such as when a person is writing while seated at a desk.
- B. The sensor shall be a completely self-contained control system that replaces a standard toggle switch. Switching mechanism shall be a latching air gap relay, compatible with electronic ballasts, compact fluorescent, and inductive loads. Triac and other harmonic generating devices shall not be allowed. Sensor shall have ground wire and grounded strap for safety.
- C. Sensor shall utilize advanced control logic based on RISC (Reduced Instruction-Set Circuit) microcontroller.
- D. To avoid false ON activations and to provide immunity to RFI and EMI, a technology shall be used to respond only to those signals caused by human motion.

- E. The sensor shall utilize continuously adjusting Zero Cross Relay control.
- F. Sensors shall utilize 'Smart Set' technology to optimize time delay and sensitivity settings to fit occupant usage patterns. The use of Smart Set shall be selectable with a DIP switch.
- G. Sensor shall have a time delay that is adjusted automatically (with the Smart Set setting) or shall have a fixed time delay of 5, 10, 15, 20 or 30 minutes, walk-through mode, or test mode, set by DIP switch. In walk-through mode, lights shall turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.
- H. Sensor shall have the choice of light flash alert and/or audible alert of impending light shutoff.
- I. Sensor shall have sensitivity adjustment that is set to either automatic or reduced sensitivity.
- J. Sensor shall have a built-in light level feature selectable with DIP switch.
- K. Sensor shall have automatic-ON or manual-ON operation.
- L. Sensor shall operate at universal voltages.
- M. Sensor shall be capable of switching 0-800 watts fluorescent/incandescent or 1/6HP @ 120VAC; 0 to 1200 watts fluorescent or 1/6 HP @ 230/277VAC.
- N. The sensor shall utilize a temperature-compensated dual element sensor and a multi-element Fresnel lens.
- O. Fresnel lens shall be made of hard, 1.0mm Poly IR 2 material for greater sensitivity and detection performance. Lens shall have grooves facing in to avoid dust and residue build up.
- P. To assure detection at desktop level uniformly across the space, sensor shall have a two-level, 28-segment multi-element Fresnel lens system.
- Q. Sensor shall cover up to 300 square feet for walking motion, with a field of view of 180 degrees.
- R. The sensor shall not protrude more than 3/8" from the wall and should blend in aesthetically.
- S. Adjustments and mounting hardware shall be concealed under a removable, tamper resistant cover.
- T. Provide as dual relay model where indicated on drawings.
- U. Manufacturers: Watt Stopper PW-100/200 series, Lutron, Sensor Switch, or approved equal.

## 2.02 OCCUPANCY SENSORS (CEILING MOUNT, 360 DEG, DUAL TECHNOLOGY)

- A. The Dual Technology sensor shall be capable of detecting presence in the control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes.
- B. Sensor shall utilize Dual Sensing Verification Principle for coordination between ultrasonic and PIR technologies. Detection verification of both technologies must occur in order to activate lighting systems. Upon verification, detection by either shall hold lighting on.
- C. Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.
- D. Sensors shall be mounted to the ceiling with a flat, unobtrusive appearance and provide 360deg of coverage.
- E. Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 KHz. It shall utilize Advanced Signal Processing which automatically adjusts the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.
- F. To avoid false ON activations and to provide immunity to RFI and EMI, a technology shall be used to respond only to those signals caused by human motion.
- G. The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall be Poly IR4 material to offer superior performance in the infrared wavelengths and filter short wavelength IR, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up.
- H. Sensors shall operate at 24 VDC/VAC and halfwave rectified and utilize a power pack.
- I. Sensors shall utilize 'Smart Set' technology to optimize time delay and sensitivity settings to fit occupant usage patterns. The use of Smart Set shall be selectable with a DIP switch.
- J. Sensors shall have a time delay that is adjusted automatically or shall have a fixed time delay of 5 to 30 minutes set by DIP switch.
- K. Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.
- L. Sensors shall have a built-in light level sensor that works from 10 to 300 footcandles.
- M. The sensors shall have a manual on function that is facilitated by installing a momentary switch.
- N. Sensors shall have eight occupancy logic options that give the ability to customize control to meet application needs.

- O. The sensor shall have an additional single-pole, double-throw isolated relay with normally open, normally closed and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options.
- P. Each sensing technology shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled for applications that require less sensor visibility.
- Q. Manufacturers: Watt Stopper DT-300 series, Lutron, Sensor Switch, or approved equal.

### 2.03 OCCUPANCY SENSORS (CEILING/WALL BRACKET MOUNT, DUAL TECHNOLOGY)

- A. The Dual Technology sensor shall be capable of detecting presence in the control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes.
- B. Sensor shall utilize Dual Sensing Verification Principle for coordination between ultrasonic and PIR technologies. Detection verification of both technologies must occur in order to activate lighting systems. Upon verification, detection by either shall hold lighting on.
- C. Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.
- D. Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 KHz. It shall utilize a technology that automatically adjusts the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.
- E. Sensor shall be capable of corner mounting to a wall or ceiling in order to eliminate detection through open doorways and outside of controlled area. Coverage of both technologies must be complete and overlapping throughout the controlled area.
- F. To avoid false ON activations and to provide immunity to RFI and EMI, a technology shall be used to respond only to those signals caused by human motion.
- G. Sensor shall operate at 24 VDC/VAC and halfwave rectified and utilize a power pack.
- H. The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall be Poly IR4 material to offer superior performance in the infrared wavelengths and filter short wavelength IR, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.
- I. The lens shall cover up to 2000 square feet for walking motion when mounted at 10 ft and 1000 sq ft of desktop motion.



- J. DT-200 sensors shall have an additional single-pole, double throw isolated relay with normally open, normally closed and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options.
- K. Sensors shall utilize 'Smart Set' technology to optimize time delay and sensitivity settings to fit occupant usage patterns. The use of Smart Set shall be selectable with a DIP switch.
- L. Sensors shall have a time delay that is adjusted automatically (with the Smart Set setting) or shall have a fixed time delay of 5 to 30 minutes.
- M. Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.
- N. Sensor shall have an override-ON function for use in the event of a failure.
- O. Sensor shall have a built-in light level sensor that works from 10 to 300 footcandles.
- P. Each sensing technology shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled.
- Q. Manufacturers: Watt Stopper DT-200 Series, Lutron, Sensor Switch, or approved equal.

#### 2.04 OCCUPANCY SENSORS (CEILING MOUNT, ULTRASONIC)

- A. The ultrasonic occupancy sensors shall be capable of detecting presence in the floor area to be controlled by detecting Doppler shifts in a transmitted ultrasound.
- B. Ultrasonic sensing shall be volumetric in coverage with a frequency of 40KHz. It shall utilize a technology that automatically adjusts the detection threshold to compensate for changing levels of activity and airflow throughout the controlled space.
- C. To avoid false ON activations and to provide immunity to RFI and EMI, a technology shall be used to respond only to those signals caused by human motion.
- D. Sensors of varying frequencies shall not be allowed so as to prevent sensors from interfering with each other and to assure compatibility in the event more sensors are added.
- E. The UT-300 sensor shall operate at 24 VDC/VAC and half-wave rectified and utilize a power pack.
- F. UT-355 shall incorporate a switching power supply for reduced power consumption; shall operate at 120/230/277 VAC, and shall not require a power pack. The UT-355 shall be utilized in areas with inaccessible ceiling spaces.
- G. Detection shall be maintained when a person moves only within or a maximum distance of 12 inches either in a horizontal or vertical manner at the approximate speed of 12 inches per second.

- H. The UT-300 sensor shall have a manual 'on' function that is facilitated by installing a momentary switch.
- I. Sensors shall be mounted to the ceiling with a flat, unobtrusive appearance and provide 360 deg of coverage.
- J. Sensors shall utilize 'Smart Set' technology to optimize time delay and sensitivity settings to fit occupant usage patterns. The use of Smart Set shall be selectable with a DIP switch.
- K. Sensor shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after 30 seconds.
- L. UT-300 sensor shall have an additional single-pole, double throw isolated relay with normally open, normally closed and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options.
- M. Sensors shall have a time delay that is adjusted automatically (with the Smart Set setting) or shall have a fixed time delay of 5 to 30 minutes.
- N. The sensor shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled.
- O. Approved Manufacturer: Watt Stopper UT-300 / UT-355, Lutron, Sensor Switch, or approved equal.

#### 2.05 POWER AND AUXILIARY RELAY PACKS

- A. Power pack shall be a self-contained transformer and relay module in a single small package.
- B. Power and auxiliary relay packs shall have dry contacts capable of switching 20 amp ballast load, 13 amp incandescent, 1 hp @ 120 VAC; 20 amp ballast @ 277VAC; 15 amp ballast, 1 hp @ 220-240 VAC.
- C. Power packs shall provide a 24 VDC, 150mA output/
- D. Power packs shall be capable of parallel wiring without regard to AC phases on primary.
- E. Auxiliary relay packs shall contain no transformer power supply and shall switch 120 VAC, 277 VAC or low voltage.
- F. Power and auxiliary relay packs shall have low voltage Teflon coated leads, rated for 300 volts, suitable for use in plenum applications.
- G. Power pack shall be UL 2043 rated, use UL94 V-O plenum rated plastic, and have low voltage Teflon leads for use in plenum applications.
- H. Power packs shall utilize Zero Crossing Circuitry.
- I. Manufacturers: Watt Stopper, Lutron, Sensor Switch, or approved equal.

- 2.06 EMERGENCY BYPASS RELAY
  - A. Manufacturer: L C & D GR2001 E/S.
- 2.07 DIGITAL OCCUPANCY SENSOR (AUTOMATIC WALL SWITCH, DUAL TECHNOLOGY, DIMMING )
  - A. Manufacturer: nLight nWSX PDT LV DX.
- 2.08 DIGITAL OCCUPANCY SENSOR (CEILING MOUNT, 360 DEG, DUAL TECHNOLOGY)
  - A. Manufacturer: nLight nCM PDT 9.
- 2.09 DIGITAL SWITCH ( ON/OFF )
  - A. Manufacturer: nLight nPODM.
- 2.10 DIGITAL SWITCH ( ON/OFF SINGLE ZONE DIMMING )
  - A. Manufacturer: nLight nPODM DX.
- 2.11 DIGITAL SWITCH ( ON/OFF 4-ZONE DIMMING)
  - A. Manufacturer: nLight nPOD GFX.
- 2.12 DIGITAL DIMMING MODULE (0-10V)
  - A. Manufacturer: nLight nPP16D.
- 2.13 DIGITAL RAISE/LOWER INTERFACE MODULE
  - A. Manufacturer: nLight nIO RLX.
- 2.14 DIGITAL TYPE NL EMERGENCY BYPASS RELAY ( NON DIMMING APPLICATION )
  - A. Manufacturer: nLight nPP16ER.
- 2.15 DIGITAL TYPE NLD EMERGENCY BYPASS RELAY (DIMMING APPLICATION)
  - A. Manufacturer: nLight nPP16DER.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- A. It shall be the Contractor's responsibility to locate and aim sensors in the correct location required for a complete and proper volumetric coverage within the range of coverage of controlled areas per the manufacturer's recommendations. The Contractor shall provide the quantity of sensors necessary to properly and completely cover each room indicated to have occupancy sensing.

- B. The Contractor shall provide power packs as required to accomplish the occupancy sensing indicated.
- C. Mount power packs to junction boxes in accessible locations above wall switches and per the manufacturer's instructions.
- D. Mount the sensors with adapters and/or swivels per the manufacturer's instructions.
- E. Connect low voltage/digital cables per manufacturer's installation instructions.
- E. It is the Contractor's responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the Owner's facility, to verify placement of sensor and installation criteria.
- F. The Contractor shall provide, at the Owner's facility, the training to familiarize the Owner's personnel with the operation, use, adjustment, and problem-solving diagnosis of the lighting control equipment and systems.

**3.02 TESTING**

- A. The lighting control equipment and systems shall be thoroughly tested to confirm proper operation.

**END OF SECTION**

SECTION 26 20 00 - SERVICE ENTRANCE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide the secondary service entrance and metering equipment as specified herein and as shown on the Drawings.

1.02 COORDINATION

- A. Coordinate all aspects of the incoming electrical utility service with the serving utility representative.

1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Protect equipment against damage and moisture. Store materials off ground.
- B. Deliver equipment with UL label and bearing manufacturer's name.

1.04 QUALITY ASSURANCE

- A. Underwriters Laboratories, Inc., listing/approval.
- B. National Electrical Code with state and local amendments.
- C. Serving utility requirements and guidelines.

1.05 SUBMITTAL AND RECORD DOCUMENTATION

- A. Submit product data for products specified in this Section. Include dimensions, ratings, and data on features and components.

PART 2 - PRODUCTS

2.01 SWITCHBOARDS

- A. Reference Section 26 2413, Switchboards.

2.02 PANELBOARDS

- A. Reference Section 26 2416, Panelboards.

2.03 UTILITY METERING EQUIPMENT

- A. Fabricated compartment and section meeting utility company's requirements.
- B. Bus work shall include provisions for mounting utility company current transformers and potential transformers or potential taps as required by the utility company.

2.04 CURRENT TRANSFORMER CABINET

- A. Enclosure and cover to be fabricated from code gauge galvanized steel.
- B. Enclosure body to have mounting holes on back.
- C. Enclosure shall have mounting studs for utility current transformer mounting equipment.
- D. Cover shall be held secure by sliding it under the top end flange and fastening.
- E. Cover mounting studs and wing nuts shall have a utility sealing hole provision as well as a padlocking provision for sealing the cover to the enclosure.
- F. Hinged cover handles shall fold against the cover when not used.
- G. A ground lug shall be mounted on the inside bottom end of each cabinet.
- H. Shall have ANSI 49 gray enamel paint finish.
- I. Shall be UL 414 listed, type 3R, where installed outside.
- J. Acceptable Manufacturer: Circle AW or equal.

2.05 CT RATED METER SOCKET

- A. Enclosure and cover to be fabricated from code gauge galvanized steel.
- B. Shall have lug range for #14 to #6 copper.
- C. Shall have test perch drilled and tapped for test switches.
- D. Shall have AWSR sealing ring.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install panels, cabinets and equipment level and plumb, parallel with structural building lines. Cover shall fit neatly without gaps, openings or distortion.
- B. Install in accordance with the manufacturer's installation instructions.

END OF SECTION

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide switchboards of a type indicated and specified herein, at locations shown on the Drawings.
- B. Utilization voltages shall be as noted on the one-line diagram or as indicated on the Drawings.

1.02 QUALITY ASSURANCE

- A. Underwriters Laboratories, Inc., listing/approval.
- B. U.L. Standard UL 891.
- C. National Electrical Code.
- D. NEMA Standard PB2.

1.03 SUBMITTAL AND RECORD DOCUMENTATION

- A. Shop drawings shall indicate the following:
  - 1. Front and side enclosure elevations with overall dimensions shown.
  - 2. Conduit entrance locations and requirements.
  - 3. Nameplate legends.
  - 4. Size and number of horizontal bus bars per phase.
  - 5. Neutral and ground.
  - 6. One-line diagrams.
  - 7. Equipment schedule.
  - 8. Switchboard instrument details.

PART 2 - PRODUCTS

2.01 DISTRIBUTION ASSEMBLY

- A. Each switchboard section shall be freestanding, dead-front type, rear-aligned, front accessible, and completely metal enclosed. Top and bottom conduit area shall be clearly shown and dimensioned on the Shop Drawings. All front plate devices used for mounting switches or installed and laced with flexibility at the hinged side. Formed removable closure plates shall be used on the front, rear, and sides. All closure plates are to be single-tool, screw removable. Overcurrent devices shall be of size and type as indicated on the Drawings.
- B. The paint finish shall be two coats gray enamel over a rust-inhibiting phosphate primer.
- C. Main lugs shall be tool-applied compression-type.

- D. The bus bars shall be tin-plated aluminum and rigidly braced for 65,000 amperes RMS symmetrical at rated voltage and sized as indicated on the Drawings. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Provide a full capacity neutral bus. All unused space shall be bussed and left ready for future use.
- E. A ground bus shall be firmly secured to each vertical section.
- F. Board shall be service entrance rated where used as service entrance equipment.
- G. All devices mounted in the switchboard shall have short circuit ratings to meet or exceed that of the switchboard.
- H. Switchboard shall be tested, listed, and marked for use with a UL witnessed and recognized fuse/breaker combination.
- I. Acceptable Manufacturers: Siemens, Square D, Cutler-Hammer/Westinghouse, and GE.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- A. Distribution boards shall be free from surface and finish defects. All nameplates, labels, screws, bolts or other hardware shall be in place prior to acceptance.
- B. Install panels, cabinets and equipment level and plumb, parallel with structural building lines. Switchgear panels and all electrical enclosures shall fit neatly without gaps, openings or distortion.
- C. Neatly and securely lace the conductors of each circuit together as a group and not combined with other feeders. Support laced cables and securely tie at intervals no greater than three feet to support devices built into the switchgear assembly. No loose, unsupported wire or cable will be permitted, and lugs shall not support the conductor weight.
- D. Provide engraved nameplates under the provisions of Section 16195, Electrical Identification.

#### 3.02 CONCRETE BASE

- A. Construct concrete equipment base 6" larger than footprint of cabinets and 3-1/2" tall. Where switchboard is outside, equipment base shall extend 4 feet in front of equipment as a flat level working surface.
- B. Form concrete base using framing lumber with form-release compounds. Chamfer top edges and corners.
- C. Install reinforcing bars and place anchor bolts and sleeves using manufacturer's installation template.
- D. Place concrete and allow to cure before installation of equipment.



END OF SECTION

SECTION 26 24 14 - MULTIPLE METERING CENTERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide, where indicated, as specified herein and as shown on the contract drawings.

1.02 QUALITY ASSURANCE

- A. Underwriters Laboratories, Inc., listing/approval.
- B. UL Standard 891.
- C. National Electrical Code with local amendments.
- D. NEMA Standard PB-2.

1.03 SUBMITTAL AND RECORD DOCUMENTATION

- A. Shop drawings shall indicate the following:
  - 1. Front and side enclosure elevations with overall dimensions shown.
  - 2. Floor plan and top view, indicating conduit entry locations and requirements.
  - 3. Nameplate legends.
  - 4. Size and number of horizontal bus bars per phase.
  - 5. One-line diagrams, including neutral and ground.
  - 6. Component list.
  - 7. Assembly ratings including:
    - a. Short-circuit rating.
    - b. Voltage.
    - c. Continuous current.
  - 8. Major component ratings including:
    - a. Voltage.
    - b. Continuous current.
    - c. Interrupting ratings.
  - 9. Cable terminal sizes.
- B. Where applicable, the following additional information shall be submitted.
  - 1. Busway connection.
  - 2. Connection details between close-coupled assemblies.
  - 3. Composite floor plan of close-coupled assemblies.
- C. Product data sheets for components.
- D. Record documentation shall include:
  - 1. Final as-built drawings and information for items listed above.
  - 2. Wiring diagrams.
  - 3. Certified production test reports.
  - 4. Installation and maintenance information.
  - 5. Seismic certification and equipment anchorage details.

1.04 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the switches or circuit breakers within the assembly.
- B. The meter center shall be suitable for and certified to meet all applicable requirements of the Uniform Building Code for seismic zone application. Guidelines for the installation consistent with these requirements shall be provided by the meter center manufacturer and be based upon testing of representative equipment.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Siemens, Square D, Cutler-Hammer/Westinghouse, and GE.

2.02 RATINGS

- A. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of 65,000 amperes symmetrical at rated voltage.
- B. Meter center shall be tested, listed, and marked for use with a UL witnessed and recognized breaker combination.

2.03 CONSTRUCTION

- A. The entire assembly shall be front accessible and shall consist of main lugs or main device as shown on the Drawings.
- B. All metering shall be in accordance with the serving utility requirements.
- C. Tenant disconnects shall be wired for hot sequence and shall be molded case breakers as shown on the Drawings.
- D. The meter sockets and associated branch protective devices shall be completely prewired and shipped ready for installation of the meters. Meter sockets shall include covers with sealing provisions.
- E. Feeder devices, shall be panel mounted type construction.

2.04 BUS

- A. All bus bars shall be tin-plated aluminum. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65 deg. C over a 40 deg. C ambient (outside the enclosure).
- B. Provide a full capacity neutral bus.

- C. A ground bus (minimum 1/4" x 2") shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.
- D. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.
- E. All unused space shall be bussed and left ready for future use.

**2.05 WIRING/TERMINATION**

- A. Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 deg. C of the size as indicated on the Drawings.
- B. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the Drawings.

**2.06 CIRCUIT PROTECTIVE DEVICES**

- A. Provide molded case breakers or fusible switches as indicated on the Drawings. See Section 26 28 00.

**2.07 TENANT UTILITY METERING**

- A. For EUSERC serviced areas, these switchboards shall incorporate metering sections with tenant feeder circuits, using ring-type meter sockets to meet local utility or customer requirements.
- B. The self-contained meter sockets shall include a test bypass/disconnect block per EUSERC requirements and be arranged, typically, for hot sequence metering.

**2.08 ENCLOSURES**

- A. The paint finish shall be two coats gray enamel over a rust-inhibiting phosphate primer.
- B. Outdoor NEMA 3R Enclosure:
  - 1. Outdoor enclosure shall be non-walk-in and meet applicable NEMA 3R requirements of UL.
  - 2. Enclosure shall have flat roof.
  - 3. Doors shall have provisions for padlocking.
  - 4. Ventilation openings shall be provided.

**2.09 NAMEPLATES**

- A. Provide engraved nameplates under the provisions of Section 26 05 53, Identification for Electrical Systems.

**PART 3 - EXECUTION****3.01 FACTORY TESTING**

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
  - 1. The meter centers shall be completely assembled, wired, adjusted, and tested at the factory. After assembly, the complete meter center will be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment. The main circuits shall be given a dielectric test of 2,200 volts for one minute between live parts and ground and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1,500 volts for one minute between live parts and ground.
- B. The manufacturer shall provide three certified copies of factory test reports.

**3.02 INSTALLATION**

- A. The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.
- B. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the concrete housekeeping pad without the use of floor sills. All necessary hardware to secure the assembly in place shall be provided by the Contractor.
- C. Install level and plumb, parallel with structural building lines. Metergear panels and all electrical enclosures shall fit neatly without gaps, openings, or distortion.

**END OF SECTION**

**SECTION 26 24 16 - PANELBOARDS**

**PART 1 - GENERAL**

**1.01 DESCRIPTION**

- A. Provide at locations shown on the Drawings, panelboards of a type indicated and specified herein.

**1.02 COORDINATION**

- A. Coordinate with other Trades affecting or affected by Work of this Section.

**1.03 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Protect against damage and moisture. Store materials off ground. Remove damaged materials from site immediately after detection.
- B. Deliver with UL label and bearing manufacturers name. Panelboard exterior trim separately packaged to prevent damage during delivery and storage on site.
- C. Store and handle panelboards so as not to subject them to corrosion or mechanical damage and in a manner to prevent damage from environment and construction operation.

**1.04 QUALITY ASSURANCE**

- A. Underwriters Laboratories, Inc. listing/approval.
- B. Underwriters Laboratories, Inc. Standards.
  - 1. Panelboards - UL67.
  - 2. Cabinet and Boxes - UL50.
- C. National Electrical Code.
- D. NEMA Standard - PB1.

**1.05 SUBMITTAL AND RECORD DOCUMENTATION**

- A. Approval documents shall include drawings. Drawings shall contain overall panel dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one-line diagrams with applicable voltage systems. Include copy of panel schedules in record documents.

**PART 2 - PRODUCTS**

**2.01 PANELBOARDS**

- A. Panels shall be factory pre-assembled using tin-plated aluminum bussing and bolt-on circuit breakers. Separate feeder lugs shall be provided for each feeder conductor. They shall be so designed that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors, so that circuits may be changed without machine drilling or tapping.
- B. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. A nameplate shall be provided listing panel type and ratings.
- C. Unless otherwise noted, full size insulated neutral bars shall be included. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection. A separate ground bus shall be included in all panels. There shall be a neutral and ground bus space for each breaker location listed as space.
- D. Panelboard boxes shall be at least 20" wide, made from galvanized steel. Provide minimum gutter space in accordance with National Electrical Code. Maximum panel depth shall be 5-3/4", unless otherwise shown or specifically approved by the Owner. Surface panel boxes shall be painted to match trim.
- E. Switching device handles shall be accessible. Doors and panelboard trims shall not uncover any live parts.
- F. All panel doors shall be provided with a flush type combination catch and lock with two milled keys. On doors more than 48" high, a three point combination catch and lock shall be provided with a vault type handle. All locks shall be keyed alike. All panel trims shall be "hinged front" construction, meaning trim has a piano hinge down one side, door opens by a single latch, and entire trim hinges open by removing two screws.
- G. Single pole breakers shall be full module size; two poles shall not be installed in a single module. Each breaker shall be securely fastened to prevent movement and trims shall fit neatly and tightly to the breaker assembly. Interrupting capacity shall be minimum 10,000 ampere or as indicated on the Drawings and shall conform to Fed. Spec. W-C-375. All 15 or 20 ampere single pole breakers shall have "switching-duty" capability.
- H. Permanent numbers, engraved, stamped or painted shall be affixed to each pole next to breakers. Stick-on numbers are not acceptable.
- I. Panelboards shall be coated with a rust inhibiting phosphate primer and two coats of light gray enamel. Trims to be separately packed and protected from scratching and marring.
- J. Panelboards shall be tested, listed, and marked for use with a UL witnessed and recognized fuse/breaker combination.

## 2.02 ACCEPTABLE MANUFACTURERS

- A. Siemens, Square D, Cutler-Hammer/Westinghouse, and GE.

**PART 3- EXECUTION**

**3.01 INSTALLATION**

- A. Breaker handle guards shall be provided on each circuit supplying obviously constant loads to prevent accidental shutting off. Such loads are contactor controlled circuits, freeze protection, etc.
- B. Provide typed schedules as in Section 26 0553.
- C. Provide engraved laminated name plates under the provisions of Section 26 0553.
- D. Provide one 3/4" spare conduit stubbed into an available accessible space above for every three single pole spare or space in new flush branch panels.

**END OF SECTION**



SECTION 26 24 17 - LOAD CENTERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide at locations shown on the Drawings, load centers of a type indicated and specified herein.

1.02 COORDINATION

- A. Coordinate with other Trades affecting or affected by Work of this Section.

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protect against damage and moisture. Store materials off ground. Remove damaged materials from site immediately after detection.
- B. Deliver with UL label and bearing manufacturers name. Load center exterior trim separately packaged to prevent damage during delivery and storage on site.
- C. Store and handle load centers so as not to subject them to corrosion or mechanical damage and in a manner to prevent damage from environment and construction operation.

1.04 QUALITY ASSURANCE

- A. Underwriters Laboratories, Inc. listing/approval.
- B. Underwriters Laboratories, Inc. Standards.
  - 1. Load centers - UL67.
  - 2. Cabinet and Boxes - UL50.
- C. National Electrical Code.
- D. NEMA Standard 250.

1.05 SUBMITTAL AND RECORD DOCUMENTATION

- A. Approval documents shall include drawings. Drawings shall contain overall load center dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one-line diagrams with applicable voltage systems. Include copy of panel schedules in record documents.

PART 2 - PRODUCTS

2.01 LOAD CENTERS

- A. Load centers shall be factory pre-assembled using copper bussing and plug-on circuit breakers. Separate feeder lugs shall be provided for each feeder conductor. They shall be so designed that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors, so that circuits may be changed without machine drilling or tapping.
- B. Branch circuits shall be arranged using double row construction. A nameplate shall be provided listing load center type and ratings.
- C. Unless otherwise noted, full size insulated neutral bars shall be included. Bus bar taps for load centers with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection. A separate ground bus shall be included in all load centers. There shall be a neutral and ground bus space for each breaker location listed as space.
- D. Load center boxes shall be at least 14" wide, made from galvanized steel. Provide minimum gutter space in accordance with National Electrical Code. Maximum load center depth shall be 5-3/4", unless otherwise shown or specifically approved by the Owner. Surface load center boxes shall be painted to match trim.
- E. Switching device handles shall be accessible. Doors and load center trims shall not uncover any live parts.
- F. Single pole breakers shall be full module size; two poles shall not be installed in a single module. Each breaker shall be securely fastened to prevent movement and trims shall fit neatly and tightly to the breaker assembly. Interrupting capacity shall be minimum 10,000 ampere or as indicated on the Drawings. All 15 or 20 ampere single pole breakers shall have "switching-duty" capability.
- G. Permanent numbers, engraved, stamped or painted shall be affixed to each pole next to breakers.
- H. Load centers shall be coated with a rust inhibiting phosphate primer and two coats of light gray enamel. Trims to be separately packed and protected from scratching and marring.
- I. Load center shall be tested, listed, and marked for use with a UL witnessed and recognized fuse/breaker combination.

## 2.02 ACCEPTABLE MANUFACTURERS

- A. Siemens, Square D, Cutler-Hammer/Westinghouse, GE, and Challenger.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Breaker handle guards shall be provided on each circuit supplying obviously constant loads to prevent accidental shutting off. Such loads are contactor controlled circuits, freeze protection, etc.
- B. Provide typed schedules as in Section 26 05 53.

- C. Provide engraved laminated name plates under the provisions of Section 26 05 53.
- D. Install load centers plumb in conformance with NEMA PD1.1.
- E. Height: 6'-6" to top.
- F. Adjust trim to cover all openings.
- G. Provide filler plates for unused spaces in load centers.

**3.02 FIELD QUALITY CONTROL**

- A. Measure steady state load currents at each load center feeder. Should the difference at any load center between phases exceed 20 percent, rearrange circuits in the load center to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.
- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers and fuses.

**END OF SECTION**

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide all wiring devices and finish plates as required unless specifically indicated otherwise.

1.02 QUALITY ASSURANCE

- A. Underwriters Laboratories, Inc., listed and NEC approved.
- B. Wiring devices shall be specification grade, with special devices as noted on the Drawings. Should the Drawings indicate a device other than those listed herein, such device shall be of same grade and manufacture as specified below.
- C. All lighting switches and duplex receptacles installed shall be from the same manufacturer and have identical appearance characteristics.

1.03 SUBMITTAL AND RECORD DOCUMENTATION

- A. Submit product data for wiring devices and cover plates.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Wall Switches: 20 ampere, 120/277 volt AC, quiet type, Hubbell HBL1221 Series, color as selected by Architect. Single pole, double pole, 3-way, locking, or other type as indicated. Switches connected to emergency circuits shall be red.
- B. Receptacles: Single and duplex receptacles shall be rated 20 amperes, 125 volts, two-pole, three-wire, grounded type, Hubbell HBL5362 Series. Receptacles shall have nylon faces, one-piece brass mounting strap with integral ground contacts and bypass power contacts; color as selected by Architect. Receptacles connected to emergency circuits shall be red.
- C. Receptacles with ground fault interrupters shall be in accordance with UL 943.
- D. Special purpose or heavy duty receptacles shall be of the type and of ratings and number of poles indicated or required for the anticipated purpose. Contact surfaces may be either round or rectangular. One appropriate straight or angle-type plug shall be furnished with each receptacle. Locking facilities, where indicated, shall be accomplished by the rotation of the plug.

- E. Device plates of the one-piece type shall be provided for all outlets and fittings to suit the devices installed. Plates on unfinished walls and on fittings shall be of zinc-coated sheet steel, cast metal, or impact resistant plastic having rounded or beveled edges. Plates on finished walls shall be impact-resistant plastic, color as selected by the Architect. Plates on emergency receptacles and switches shall be red.
- F. Receptacles in wet locations shall be in a weatherproof enclosure, the integrity of which is not affected when the receptacle is in use. The enclosure shall be of high-impact polycarbonate construction, with a keyhole hinge without a spring and other metal parts, with a gasketless translucent lid that is lockable and tinted and has large cord openings. The enclosure shall be one or two-gang, and shall be securely secured to the receptacle box with tamper-proof fasteners through factory-drilled or field-drilled through factory-prepared drill points.
- G. Grainger TAYMAC 38R685 Series, or equal.
- H. Tamper-resistant (child-proof) receptacles shall be a type which contains internal contacts which require the presence of both blades to energize the receptacle. Hubbell #HBLSG62H or equal.

## 2.02 ACCEPTABLE MANUFACTURERS

- A. Hubbell, Bryant, P&S, Leviton, and Cooper.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Devices and finish plates to be installed plumb with building lines.
- B. Finish plates and devices not to be installed until final painting is complete. Scratched or splattered finish plates and devices will not be accepted.
- C. Wall mounted receptacles shall be installed vertically at centerline height shown on the Drawings unless otherwise specified.
- D. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch.
- E. All outlets shall have a cover plate. Provide blank cover plate to match surrounding area if none other is specified.

### 3.02 TESTS

- A. Test all receptacles for line to line, line to neutral, line to ground, and neutral to ground, opens or shorts, and correct defective wiring.

### 3.03 LABELING

- A. See Section 26 05 53, Identification for Electrical Systems.

END OF SECTION

SECTION 26 28 20 - ELEVATOR POWER MODULE SWITCH

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work of this section shall conform to the requirements of the Contract Documents.

1.02 SECTION INCLUDES

- A. Provide Elevator Power Module Switch(es), fuses, and accessories as required and as specified on Contract Drawings to distribute electrical power to all elevators.

1.03 CODES AND STANDARDS

- A. All work shall be performed in accordance with the latest edition of the National Electrical Code and all other applicable standards, codes, and laws.
  - 1. National Electrical Code, 1996.
  - 2. ASME/ANSI A17.1.111b.
  - 3. BOCA 1993.
- B. Except as modified by governing codes, all equipment shall be manufactured in accordance with the latest applicable standards:
  - 1. UL Standard 50, Cabinet Boxes
  - 2. Federal Specifications, Fused Switches W-S-865C

1.04 SUBMITTALS

- A. Submit shop drawings and product data under the provisions of the General Conditions.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, configurations, and methods of mounting and installation.
- C. Submit listing of all types, sizes, and quantity of fuses which will be installed including the location of each.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Bussman, Littlefuse, and Ferraz-Shawmut.

2.02 GENERAL

- A. Provide elevator power module switch as shown on drawings.
- B. The elevator power module switch shall be constructed with Nationally Recognized Testing Laboratory (NRTL) devices and to the codes and standards as listed above.

- C. The power module switch shall have an ampere rating as shown on the Contract Drawings, and shall include a horsepower rated fusible switch with shunt trip capabilities.
- D. It shall include as an accessory a control power transformer with a primary voltage rating as required and a 120 volt secondary.
- E. The module shall have been successfully tested to a short circuit rating with Class J fuses of 200,000 amps.
- F. Switch shall have shunt trip capabilities at 120V AC for remote fire safety signal. (Note: Fire safety control voltage is normally 24V DC with interface signal off a 5 amp dry contact, which means a control power transformer and relay is necessary to activate the shunt trip solenoid - 140VA inrush at 120V, one per shunt trip mechanism.)
- G. Branch feeders shall be selectively coordinated and fed with an upstream supply overcurrent protective device at a minimum of 2:1 size ratio utilizing Low-Peak (Class J, RK1, or L) fuses.
- H. The power module switch shall have a key to test switch, and an "ON" pilot light.
- I. The power module switch shall have a mechanical interlock auxiliary contact for hydraulic elevators with automatic recall (5 amp, 120Vac rated).

**PART 3 - EXECUTION**

**3.01 INSTALLATION**

- A. All material installation shall be in accordance with manufacturer's recommendations and the provisions of applicable codes.
- B. Fuses shall not be installed until equipment is ready to be energized.
- C. Coordinate installation requirements with elevator supplier.

**END OF SECTION**



## SECTION 26 32 13 - DIESEL-ENGINE-DRIVEN GENERATOR SETS

## PART 1 - GENERAL

## 1.01 DESCRIPTION

- A. Provide complete factory assembled diesel engine driven electric generator set and related equipment as specified herein and as shown on the drawings.
- B. Provide factory test, startup by a supplier authorized by the equipment manufacturer(s), and on-site testing of the system.
- C. The generator set manufacturer shall warrant all equipment provided under this section, whether or not it is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

## 1.02 QUALITY ASSURANCE

- A. The generator set installation and on-site testing shall conform to the requirements of the following codes and standards, as applicable. The generator set shall include necessary features to meet the requirements of these standards.
  - 1. CSA 282 – Emergency Electrical Power Supply for Buildings
  - 2. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
  - 3. NFPA37
  - 4. NFPA70 – National Electrical Code with any State modifications. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
  - 5. NFPA99 – Essential Electrical Systems for Health Care Facilities
  - 6. NFPA110 – Emergency and Standby Power Systems. The generator shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit. Component level type tests will not substitute for this requirement.
- B. The generator set and supplied accessories shall meet the requirements of the following standards:
  - 1. NEMA MG1. Alternator shall comply with the requirements of the current version of this standard as they apply to AC alternators.
  - 2. UL142 – Sub-base Tanks
  - 3. UL1236 – Battery Chargers
  - 4. UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.
- C. The control system for the generator set shall comply with the following requirements:
  - 1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
  - 2. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.

3. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
  4. FCC Part 15, Subpart B.
  5. IEC8528 part 4. Control Systems for Generator Sets
  6. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
  7. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
  8. UL1236 – Battery Chargers.
- D. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

### 1.03 SUBMITTALS

- A. Shop Drawings: Detail fabrication, piping, wiring, and installation of the field-installed portions of the system. Include general arrangement drawings showing locations of auxiliary components in relation to the engine generator set and duct, piping, and wiring connections between the generator set and the auxiliary equipment. Show connections, mounting, and support provisions and access and working space requirements. Single-line diagrams of transfer switch units showing connections between automatic transfer switch, power source and load, wiring diagrams, elementary or schematic, differentiating between manufacturer-installed and field-installed wiring, including required interconnection between the generator set, the transfer switch, and the remote annunciator panel.
- B. Product Data: Include data on features, components, ratings, and performance. Include dimensioned outline plan and elevation drawings of engine generator set and other system components. Include product data for each transfer switch, including dimensioned plans, sections, and elevations showing minimum clearances; conductor entry provisions; gutter space; installed features and devices; and materials lists. Provide motor-starting KVA performance data (graphical) along with calculations indicating worst-case motor starting scenario. See drawings for loads on the generator, and confirm load sizes with actual equipment to be furnished.
- C. Operating and Maintenance Data.
- D. Factory Start-Up Test Report.
- E. Site Test Report.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Acceptable Manufacturers: Caterpillar, Kohler, Cummins, Olympian, Generac, and MTU Onsite Power.
- B. Other Manufacturers: Submit Substitution Request prior to bid date.

## 2.02 GENERATOR SET:

- A. Generator set shall be the product of a manufacturer regularly engaged in the production of this type of equipment and one that has a local distributor and service organization. The generator shall have a continuous standby rating as indicated on the Drawings.
- B. Factory Assembly:
1. The entire generating system shall be built, tested and shipped so as to assure the unit is factory engineered and assembled so there is only one source of supply, service, and warranty responsibility.
  2. The manufacturer shall have local parts and service facilities within a 100 mile radius of site to assure prompt emergency service within 24 hours.
  3. The manufacturer shall have a flat-rate maintenance agreement program available to the customer.
- C. Performance Requirements:
1. Frequency regulation shall be by isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
  2. Voltage manually adjustable from + 5% of nominal voltage.
  3. Ambient conditions.
    - a. Altitude of site, 100 feet.
    - b. 100 degrees F air temperature at engine intake.
  4. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
  5. Voltage transient performance +/- 20% line to line with step removal/application 30% of rated load up to 90% of rated load, including motor loads. Recovery time shall not exceed 1.5 seconds.
  6. Motor starting performance: 20% maximum line-to-line voltage dip with step removal/application of any motor load while balance of loads are running.
  7. On cold start-up voltage and frequency shall stabilize within specified bandwidths at the same time (not to exceed 2 seconds).
  8. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic, and no 3<sup>rd</sup> order harmonics or their multiples. Telephone influence factor shall be less than 40.
  9. The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable exhaust emission requirements at the time of commissioning.
- D. Construction
1. The generator set shall consist of one diesel engine directly coupled to one AC alternator, mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
  2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. All active control components shall be installed within a UL/NEMA 3R enclosure. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

- E. Connections
1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
  2. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
  3. Generator set control interfaces to other system components shall be made on a permanently labeled terminal block assembly. Labels describing connection point functions shall be provided.
- F. Engine and Engine Equipment: The engine shall be diesel, 4 cycle, radiator and fan cooled. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:
1. An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed. The governing system shall include a programmable warm up at idle and cooldown at idle function. While operating in idle state, the control system shall disable the alternator excitation system.
  2. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the alternator air inlet. Radiator fan shall be suitable for use in a system with 0.5 in H<sub>2</sub>O restriction. Radiator shall be sized based on a core temperature that is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture prior to shipping. Rotating parts shall be guarded against accidental contact.
  3. Electric starter(s) capable of three complete cranking cycles without overheating.
  4. Positive displacement, mechanical, full pressure, lubrication oil pump.
  5. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
  6. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.
  7. Replaceable dry element air cleaner with restriction indicator.
  8. Flexible supply and return fuel lines.
  9. Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.
  10. Coolant Heater:
    - a. Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.

- b. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall have provisions to isolate the heater for replacement of the heater element without draining the coolant from the generator set. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
  - c. The coolant heater shall be provided with a DC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
  - d. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104F (40C) in a 40F (4C) ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.
11. Provide vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.
  12. Starting and Control Batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors. The batteries shall be capable of a minimum of three complete 15-second cranking cycles at 40F ambient temperature when fully charged.
  13. Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The muffler(s) shall be critical grade. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.
  14. Provide a minimum 12 amp battery charger for each
  15. All fuel and lube oil filters shall be "spin-on" type.
  16. Provide a remote packaged fuel tank system including double-wall fuel tank, integral float switch, low fuel level warning alarm contacts and a fuel level gauge. Fuel capacity shall be 24 hours minimum at 100% loading (1700 gal min).
  17. An immersion-type oil heater operating on 120 VAC shall be installed in lube pan sump.
  18. Engine starting shall be initiated via the generator control panel mode selector switch either manually or through remote 2-wire system. It shall include an electric 24V DC starting system.
  19. Charging system shall include an engine-driven 140 amp 24V DC battery charging alternator, lead acid starting batteries rated at a minimum of 225 amp hours each, an automatic constant potential battery charger rated 10 amps, operating on 120V AC with voltmeter, ammeter, input and output fuse protection, float equalize switch, and low battery voltage contacts.
  20. Cooling system shall be unit-mounted radiator with blower-type fan to cool engine at 100% rated load at 104 degrees F ambient. Provide an immersion-type block heater with adjustable thermostat and oil pressure disconnect switch for operation on 120 V AC. Supply in system a rust inhibitor in addition to the anti-freeze required. Anti-freeze protection shall equal 0 degrees F.

21. Safety alarms shall include an automatic shutdown system to protect from high water temperature, low oil pressure, overspeed, and overcrank
  22. Instrumentation shall include control panel mounted gauges to monitor lube oil pressure, engine coolant temperature, battery charge rate, hours of operation, "Auto-Off/Reset-Test" engine mode selector switch, and push to test pilot lights indicating nature of shutdown conditions.
  23. Remote annunciator(s) shall be installed as indicated on the Drawings. The annunciator shall indicate high water temperature, anticipated high water temperature, line power, low oil pressure, anticipated low oil pressure, low battery voltage, and low fuel. Provide cable in 1/2" conduit between generator control panel and remote annunciator as required.
  24. A silencer shall be provided with all hangers, etc. as needed for a complete installation.
  25. A prime-mover emergency off switch shall be located outside the generator room.
- G. General Description - Alternator:
1. Alternator shall be a brushless, single bearing, and directly coupled to the engine flywheel via a flexible disk. It shall be engine driven, synchronous type, with amortisseur windings. Insulation shall be non-hygroscopic Class H, with a temperature rise not to exceed 105 degrees C above a 40 degrees C ambient. Alternator shall be a 10 or 12 lead machine with leads brought to a terminal box.
  2. Voltage regulator shall be a solid-state type with no moving parts. It shall include overvoltage and underfrequency protection and be moisture proof.
  3. Alternator and control panel strip heaters for use on 120V AC to raise the temperature 35 degrees C above ambient for moisture protection. Provide relay to disconnect heaters when generator is running.
  4. Instrumentation includes controller with advanced control, system monitoring, and system diagnostics for optimum performance and compatibility – 12" graphic display with touch screen and menu, two USB ports, ethernet port, supports Modbus RTU and TCP protocols, NFPA 110 Level 1 capability. Engine and breaker must be manually reset after shutdown. Breaker shall not trip on overcrank. The control panel shall contain field adjustable circuitry for overcrank protection designed to open the cranking circuit after a minimum of three cranking cycles of 30 second crank/15 second pause if engine fails to start.
- H. Vibration isolation shall be accomplished by mounting unit on a minimum of six spring-type vibration isolators with adjusting screws and earthquake restraints (or integral vibration isolation as recommended by manufacturer).

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Install the engine-generator set, battery charger, and batteries per the manufacturer's recommendations and as shown on the Drawings.
- B. Provide proper filters for fuel and lubricating oils and fill engine with proper type and amount of oil.

- C. Fill the engine cooling system with ethylene-glycol antifreeze solution and water in a 50/50 mixture.
- D. Provide all necessary connections for a complete and operating installation.

### 3.02 MAINTENANCE INSTRUCTIONS

- A. All personnel directly concerned with the operation of the system shall be thoroughly instructed in the use of the systems by authorized distributor personnel. Such service shall be provided in conjunction with the system equipment. Allocate 4 hours of site training for Owner's personnel. Schedule training time with Owner.

### 3.03 WARRANTY

- A. The complete diesel engine generator system shall be guaranteed for two years from date of acceptance.
- B. In addition to the manufacturer's standard three-year warranty, the warranty shall include 100% parts, labor, travel mileage, transportation costs, and freight associated with failure unless failure is caused by misuse, abuse, or accident (e.g. fires, floods, etc.). Manufacturer's factory service personnel, skilled in the repair of the unit, shall be dispatched to repair the equipment at the site within 24 hours after receiving the purchaser's call.

### 3.04 TESTING

- A. Prior to installation of the engine generator set, a factory test shall be performed and a logged test report issued to the Owner. A resistive load bank shall be connected to the load side of the standby generator. The load bank shall be used to test the generator set for full load and half load. The log shall include the length of time for generator set start-up after the commercial source is interrupted, the length of time for the generator set to reach frequency stability after zero to half load and from half load to full load switching. The generator set shall be run for a minimum of four hours at full load. All the temperatures of the engine and the voltages, frequency and amperages shall be recorded on every 15 minute interval during the test.
- B. A site test shall be performed, logged and witnessed by the Owner's representative. The total facility standby load shall be connected to the unit for one full hour. Each breaker shall be used to approximate half and full load. The log shall indicate the same information contained in the pre-installation test. Notify the Owner 72 hours in advance so that his representative can be present at the test.

### 3.05 ACCEPTANCE

- A. Upon satisfactory completion of tests instruction and completion of the project, the system shall be deemed accepted.

END OF SECTION

## SECTION 26 36 23 - AUTOMATIC TRANSFER SWITCHES

## PART 1 - GENERAL

## 1.01 DESCRIPTION

- A. Provide automatic transfer switches as specified herein and shown on the Drawings for the reconnection of loads from the commercial powered bus to the standby power supply during interruption of the utility service to the building.
- B. Provide associated control wiring.

## 1.02 QUALITY ASSURANCE

- A. Transfer switches shall comply with the applicable standards of UL, CSA, ANSI, NFPA, IEEE, NEMA, and IEC.

## 1.03 SUBMITTAL AND RECORD DOCUMENTATION

- A. Product Data: Provide catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C. Operation Data: Instructions for operating equipment under emergency conditions.
- D. Maintenance Data: Routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

## PART 2 - PRODUCTS

## 2.01 AUTOMATIC TRANSFER SWITCHES

- A. Acceptable Manufacturers: Kohler, Cummins, Asco, Zenith, Thomson Technology, or approved.
- B. General:
  - 1. The transfer switch shall be rated for the voltage and ampacity as shown on the plans and shall have 600 volt insulation on all parts in accordance with NEMA standards.
  - 2. The current rating shall be a continuous rating when the switch is installed in an unventilated enclosure, and shall conform to NEMA temperature rise standards.
  - 3. The unit shall be rated based on all classes of loads, i.e., resistive, tungsten, ballast, and inductive loads. Switches rated 400 Amperes or less shall be UL listed for 100% Tungsten load.



4. As a precondition for approval, all transfer switches complete with accessories shall be listed by Underwriters Laboratories, under standard UL-1008 (automatic transfer switches), and approved for use on emergency systems.
5. The withstand current capacity of the main contacts shall not be less than 20 times the continuous duty rating for a minimum of three electrical cycles as established by certified test data.
6. Temperature rise tests in accordance with UL-1008 shall have been conducted after the overload and endurance tests to confirm the ability of the units to carry their rated currents within the allowable temperature limits.
7. The transfer switches shall be supplied with a microprocessor-based control panel as detailed further in these specifications.
8. A bypass-isolation transfer switch shall be provided to manually permit convenient electrical bypass and isolation of the automatic transfer switch that could not otherwise be tested, inspected and maintained without interrupting the load. Bypass of the load to either the normal or emergency power source with complete isolation of the automatic transfer shall be possible regardless of the status of the automatic transfer switch. The bypass-isolation switch shall permit proper operation by one person through the movement of a maximum of two handles. The entire system shall consist of two elements: the automatic transfer switch and the bypass-isolation switch furnished completely factory interconnected and tested.
9. The operating speed of the bypass-isolation switch contacts shall be independent of the speed of operation of the bypass handle.
10. The isolation handle shall provide three positions: Automatic, Test and Isolate. The test position shall permit electrical testing of the automatic transfer switch without disturbing the load. The Isolate position shall completely isolate the transfer switch from both sources and load without actual removal of the line or load conductors and allow its removal for inspection and maintenance. The transfer switch shall be arranged for drawout operation to facilitate its removal. Also, while in the Test or Isolate positions, the bypass-isolation switch shall function as a manual transfer switch to allow load transfer to either source of power regardless of the position or condition of the transfer switch including the condition when the transfer switch is removed, and without reconnecting the load terminal of the transfer switch.
11. The load shall not be interrupted during bypass-isolation functions. The addition of load-break contacts that cause load interruption is not acceptable. The bypass-isolation switch contacts shall not be in the system current path except during actual bypass operation.
12. The bypass-isolation transfer switch shall be furnished with a detailed step-by-step operating instruction plate as well as the following function diagnostic lights:
  - a. Normal source available
  - b. Emergency source available
  - c. Bypass switch in normal position
  - d. Bypass switch in emergency position

- e. Automatic transfer switch in test position
  - f. Automatic transfer switch isolated
  - g. Automatic switch inhibit
  - h. Automatic transfer switch operator disconnect switch "OFF"
  - i. Automatic transfer switch in normal position
  - j. Automatic transfer switch in emergency position.
13. The bypass-isolation switch shall be equipped with an independent engine start circuit so that, should a utility outage occur while in the bypass-normal/ATS isolated condition, the engine will automatically start and allow immediate selection of emergency bypass.
  14. The complete bypass-isolation transfer switch shall be tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency, and time delay settings are in compliance with the specification requirements.
  15. The bypass-isolation transfer switch shall be the product of one manufacturer and completely factory interconnected and tested so that only the services and load connections to the bypass-isolation switch are require for field installation. All interconnections between the transfer switch and the bypass-isolation switch shall be silver-plated copper bus bar. A visual position indicator shall be provided to indicate bypass-isolation switch positions. Enclosure construction shall be in accordance with UL and NEMA standards for industrial controls.
- C. Sequence of Operation:
1. The ATS shall incorporate adjustable 3-phase under- and over-voltage and 3-phase under- and over-frequency sensing on the normal source.
  2. When the voltage of any phase of the normal source is reduced to 80% or exceeds 110% nominal voltage, or frequency is displaced 2 Hz from nominal, for a period of 0-10 seconds (programmable), a pilot contact shall close to initiate starting of the engine generator.
  3. The ATS shall incorporate adjustable 3-phase under- and over-voltage and 3-phase under- and over-frequency sensing on the emergency source.
  4. When the emergency source has reached a voltage value within +/- 10% of nominal and achieved frequency within +/- 5% of the rated value, the load shall be transferred to the emergency source after a programmable time delay.
  5. When the normal source has been restored to not less than 90% of rated voltage on all phases, the load shall be retransferred to the normal source after a time delay of 0 to 30 minutes (programmable). The generator shall run unloaded for 5 minutes (programmable) and then automatically shut down. The generator shall be ready for automatic operation upon the next failure of the normal source.
  6. If the engine generator should fail while carrying the load, retransfer to the normal source shall be made instantaneously upon restoration of proper voltage (90%) on the normal source.
  7. The transfer switch shall be equipped with a microprocessor-based control panel. The control panel shall perform the operation and display functions of the transfer switch. The display functions of the control panel shall include ATS position and source availability.

8. The digital display shall be accessible without opening the enclosure door and shall be provided with a 4-line by 20-character LCD display screen with touch pad function and display menus. The programming functions shall be pass-code protected.
  9. The control panel shall be provided with menu-driven display screens for transfer switch monitoring, control and field changeable functions and settings.
  10. The control panel shall be optoisolated from electrical noise and provided with the following inherent control functions and capabilities:
    - a. Multipurpose display for continuous monitoring and control of the ATS functions and settings. All field-changeable functions shall be pass-code protected and accessible through the keypad.
    - b. Built-in diagnostic display that includes the capturing of historical data, such as number of transfers and time on emergency power source, for ease of troubleshooting.
    - c. Capability for external communication and network interface through an RS485 serial port.
    - d. Touch pad test switch with Fast Test/Load/No Load positions to simulate a normal source failure.
    - e. Time delay to override momentary normal source failure prior to engine start. Field programmable 0-10 seconds (adjustable by increments of 0.1 seconds) factory set at 3 seconds.
    - f. Time delay on retransfer to normal source, programmable 0-60 minutes (adjustable by increments of 0.1 minutes) factory set at 30 minutes. If the emergency source fails during the retransfer time delay, the transfer switch controls shall automatically bypass the time delay and immediately retransfer to the normal position.
    - g. Time delay on transfer to emergency, programmable 0-5 minutes, factory set at 1 second.
    - h. Terminals for remote test/peak shave operation and transfer inhibit to the emergency source.
    - i. An in-phase monitor shall be provided. The monitor shall compare the phase angle difference between the normal and emergency sources and be programmed to anticipate the zero crossing point to minimize switching transients.
    - j. Auxiliary contacts (1 N.O.) shall be provided to indicate normal and emergency source availability.
    - k. A load/no load clock exerciser shall be incorporated within the microprocessor and shall be programmable to start the engine generator set and transfer the load (when selected) for exercise purposes on a weekly basis. The exerciser shall contain a lithium battery for memory retention during an outage.
    - l. A timed auxiliary contact (1 N.C.) adjustable 0-60 seconds shall be provided to allow motor loads to be disconnected prior to transfer in either direction.
    - m. Provide a momentary pushbutton to bypass the time delays on transfer and retransfer and programmable commit/no commit control logic.
- D. Construction and Performance:
1. The automatic transfer switch shall be of double throw construction operated by a reliable electrical mechanism momentarily energized. There shall be a direct mechanical coupling to facilitate transfer in 3 cycles or less.

2. The normal and emergency contacts shall be mechanically interlocked such that failure of any coil or disarrangement of any part shall not permit a neutral position.
3. For switches installed in systems having ground fault protective devices, and/or wired so as to be designed a separately derived system by the N.E.C., a fourth pole shall be provided. This additional pole shall isolate the normal and emergency neutrals. The neutral pole shall have the same withstand and operational ratings as the other poles and shall be arranged to break last and make first to minimize neutral switching transients. Add-on or accessory poles that are not of identical construction and withstand capability are not acceptable.
4. The contact structure shall consist of a main current carrying contact which is a silver alloy with a minimum of 50% silver content. The current carrying contacts shall be protected by silver tungsten arcing contacts on all sizes.
5. The transfer switch manufacturer shall submit test data for each size switch, showing it can withstand fault currents of the magnitude and the duration necessary to maintain the system integrity. Minimum UL listed withstand and close into fault ratings shall be as follows:

<u>Size (Amps)</u>	<u>Any Molded Case Breaker*</u> <u>(RMS Symmetrical)</u>
up to 400	30,000
401-1200	50,000
1201-4000	100,000

<u>Size (Amps)</u>	<u>Specific Coordinated</u> <u>Molded Case Breaker</u>
Up to 400	50,000
401-600	65,000
601-1200	85,000
1201-4000	100,000

<u>Size (Amps)</u>	<u>Current Limiting Fuse</u>
Up to 4000	200,000

\*All values 480 volt, RMS symmetrical, less than 20% power factor.

6. A dielectric test at the conclusion of the withstand and closing tests shall be performed.
7. The automatic transfer switch manufacturer shall certify sufficient arc interrupting capabilities for 50 cycles of operation to operate between normal and emergency source that are 120 degrees out of phase at 480 volts, 600% of rated current at 0.50 power factor. This certification is to ensure that there will be no current flow between the two isolated sources during switching.
8. All relays shall be continuous duty industrial type with wiping contacts. Customer interface contacts shall be rated 10 amperes minimum. Coils, relays, timers and accessories shall be readily front accessible. The control panel and power section shall be interconnected with a harness and keyed disconnect plugs for maintenance.
9. Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance.

10. A manual handle shall be provided for maintenance purposes. An operator disconnect switch shall be provided to defeat automatic operation during maintenance, inspection or manual operation.
11. The switch shall be mounted in a NEMA-1 enclosure unless otherwise indicated on the Drawings.
12. Switches composed of molded case breakers, contactors or components thereof not specifically designed as an automatic transfer switch will not be acceptable.
13. The automatic transfer switch shall be protected by a 5 year warranty, with a 10 year warranty on the main contact assembly.

### **PART 3 - EXECUTION**

#### **3.01 INSTALLATION**

- A. Install transfer switches at locations shown on drawings. Install per manufacturer's recommendations.
- B. Provide engraved plastic nameplates.
- C. Provide the services of the manufacturer's technical representative to check transfer switch connections and operations and place into service.

#### **3.02 DEMONSTRATION**

- A. Arrange and pay for the services of a factory-authorized service representative to demonstrate adjustment, operation, and maintenance of the system and to train Owner's personnel. Conduct a minimum of two hours of training.

**END OF SECTION**

SECTION 26 50 00 - LIGHTING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide all lighting outlets indicated on the Drawings with a fixture of the type designated and appropriate for the location. Outlet symbols on the Drawings without a type designation shall have a fixture the same as those used in similar or like locations.
- B. Provide lamps or LED modules for all fixtures.
- C. Coordinate installation of fixtures with the ceiling installation and all other trades to provide a total system that is neat and of orderly appearance.

1.02 QUALITY ASSURANCE

- A. Fixtures shall conform to the following specifications.
- B. Manufacturers specified are indicative of the general type and performance desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs and equivalent light distribution and brightness characteristics, and of equal finish and quality will be acceptable if approved by the Architect prior to the bid. Digital IES files shall be provided as part of Submittal and Substitution Request processes upon request in order to properly evaluate proposed fixtures.
- C. Equality shall be determined by comparisons of performance, construction, installation ease, maintenance, and appearance.
- D. All light fixtures shall be UL listed and labeled.

1.03 SUBMITTAL AND RECORD DOCUMENTATION

- A. Submit product data describing fixtures, lamps, LED modules, ballasts, drivers, and emergency lighting units. Arrange product data for fixtures in order of fixture designation.
- B. Include data on features and accessories and the following information.
  - 1. Outline drawings of fixtures indicating dimensions and principle features.
  - 2. Electrical ratings and photometric data with specified lamps/LED modules and certified results of laboratory tests, including digital IES files.
  - 3. Data on batteries and chargers of emergency lighting units.
- C. Submit shop drawings from manufacturers detailing nonstandard fixtures and indicating dimensions, weights, methods of field assembly, components, features, and accessories.

## PART 2 - PRODUCTS

## 2.01 LED FIXTURES

## A. General:

1. LED lighting fixtures shall be in accordance with IES, NFPA, UL, as shown on the Drawings and as in these Specifications.
2. LED drivers shall include the following features unless otherwise indicated:
  - a. Power factor: > 0.9 nominal
  - b. Input Voltage: 120V – 277V, 60 Hz
  - c. Total Harmonic Distortion: < 20%
  - d. Temperature Rating: 0 deg C – 40 deg C
  - e. Integral short circuit, open circuit, and overload protection.
3. LED modules shall include the following features unless otherwise indicated.
  - a. Comply with IES LM-79 and LM-80 requirements.
  - b. Minimum 80 CRI and color temperature 3500 deg K (interior) and 4000 deg K (exterior) unless otherwise specified in Lighting Fixture Schedule/List.
  - c. Minimum Rated Life: 70,000 hours per IES L70, unless otherwise specified in Lighting Fixture Schedule/List.
  - d. Light output initial lumens as specified in Lighting Fixture Schedule/List.
  - e. LED modules shall be field replaceable and contain quick-disconnects.
4. LED lighting fixtures shall have available digital IES files from a NVLAP accredited testing laboratory in accordance with IESNA LM-79, which specifies the entire luminaire as the source, resulting in an efficiency of 100%. Lighting fixtures that do not have these test results available will not be accepted.

## B. Miscellaneous:

1. All surface-mounted lighting fixtures shall have low density label.
2. All recessed lighting installed in fire-rated ceilings shall be provided with fire-rated protective covers per UL standards.
3. All fixtures mounted outdoors or in unheated spaces shall have 0 deg F ballasts/drivers.

## 2.02 RECESSED FIXTURES

- A. In insulated ceilings, recessed fixtures to be equipped with “IC” rated housing or with a field fabricated fireproof box (metal, sheet rock, etc.), complying fully with all clearance requirements.
- B. Recessed troffers shall be as follows, unless specified otherwise:
  1. Diffusers shall be pattern 12 extruded clear acrylic plastic, 0.125" overall thickness, unless otherwise specified in the fixture schedule by catalog number or remarks. Door shall be securely closed by use of enclosed cams.
  2. Finish shall be white baked enamel, unless otherwise specified with a minimum average reflectance of 85% on all exposed and light reflecting surfaces.
  3. Housing shall be 22-gauge minimum.

## 2.03 EMERGENCY LIGHTING

- A. Wall Packs:
1. Emergency wall packs shall comply with UL 924 and be self-contained units, complete with two adjustable lensed fixtures and LED modules, battery, and battery charger, suitable for 120V or 277V AC power supply as indicated on the Drawings.
  2. Battery shall be sealed, maintenance-free, lead-calcium recombination type, 10-year life expectancy. Battery shall have 1-1/2 hour minimum capacity at rated wattage to 87-1/2% of rated DC voltage from a fully charged state. Shall carry a five-year pro-rata warranty.
  3. Battery charger shall be solid-state, voltage regulated. Charge circuit shall react to the condition of the battery and alter the rate of charge in order to maintain peak battery capacity and maximum battery life.
  4. A solid-state overload monitoring device in the DC circuit shall disconnect the lamp load from the battery should excessive wattage demands be made, and automatically reset when the overload or short circuit is removed.
  5. A brownout circuit shall monitor the flow of AC current to the unit and activate the emergency lighting system when a predetermined reduction of AC power occurs.
  6. The unit shall incorporate a solid-state switching system, not relays. The switching circuit shall detect a loss of AC voltage and automatically energize the DC lamps. Upon restoration of the AC power, the emergency lamps shall switch off and the charger shall automatically recharge the battery.
  7. When the battery's terminal voltage falls below 80% of the rated voltage, the low voltage circuitry shall disconnect the lighting load. The disconnect shall remain in effect until normal utility power is restored, preventing deep battery discharge.
- B. LED Emergency Battery Backup: Emergency battery backup for LED fixtures shall be internal to the fixtures, and shall provide at least 20% of full fixtures lumen output in the emergency mode for a minimum of 90 minutes.
- C. Emergency Bypass Relay:
1. 20 amp relay, 120-277 volt operation, UL924 listed, no minimum load requirement, five-year warranty.
  2. Shall connect to the line side of the lighting control device to sense the presence of "normal" power. It shall also connect to the load side of the lighting control device to provide an ON/OFF signal for control of the emergency lights along with the general lighting.
  3. When the normal power is lost, control is suspended and the normally closed relay provides emergency power to the emergency fixtures.
  4. Provide one relay per lighting control switch leg which has emergency fixtures.
  5. Relay shall be located in accessible ceiling space (or flush mount box in hard ceiling) above the lighting controls associated with the relay.

## 2.04 OUTDOOR FIXTURES



- A. Outdoor fixtures shall be weatherproof, heavy duty types designed for efficient light utilization, adequate dissipation of lamp and ballast/driver heat and safe cleaning and relamping. Ballasts/drivers shall be incorporated within the luminaire housings unless otherwise noted. Luminaires shall be sealed unless charcoal filters are provided. Lenses shall be heat and impact resistant, tempered glass. Lens gasket shall be heat and weather resistant. Materials shall be rustproof. Latches and fittings shall be nonferrous metal or stainless steel.

## 2.05 POLES AND STANDARDS

- A. Lighting standards, assemblies, and pole bases shall be designed and constructed to withstand a steady wind velocity of 100 miles per hour without permanent distortion or displacement. Where unusual soil or base installation conditions occur, the Contractor shall provide adequate reinforcement under the guidance of the Architect to assure the specified strength for 100-mile-per-hour wind. Generally poles/bases shall be suitable for installation in earth having an allowable bearing of 1800 pounds per square foot.

## 2.6 FIXTURES

- A. See Drawings for Lighting Fixture List/Schedule.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Lamps of the proper type, wattage, and voltage rating shall be delivered to the project in the original cartons and installed in the fixtures just prior to the completion of the project. Provide lamp type as recommended by the fixture manufacturer.
- B. Fixtures shall be left clean at the time of acceptance of the work with every lamp or LED module in operation. If fixtures are deemed dirty by the Architect at completion of the project, the Contractor shall clean them.
- C. Fixtures shall be carefully aligned, leveled in straight lines, and located as shown on the Architectural reflected ceiling plan. The final decision as to adequacy of support and alignment shall be made by the Architect. The fixtures shall be supported and fastened to the ceiling system. The lighting plans are to be used for fixture types and connection information only, not exact locations.
- D. Verify all ceiling conditions and provide all lighting fixtures complete with factory furnished stems, balls, aligners, and canopies as required for a complete installation.
- E. Recessed troffers installed in suspended T-bar ceiling shall be independently supported on two opposite corners by #12 gauge steel wire attached to structure, per UBC Standard #47-18.
- F. Surface mounted light fixtures shall be securely fastened to the building surface via factory-created holes in the fixtures. Attachment of fixture merely to recessed outlet box is not sufficient.

- G. Where two switches are shown dedicated to an office, room, or area, provide two-level lighting.
- H. Lighting fixtures in any single enclosed room shall be connected using a common (one) circuit, except in cases where the loading requires a second circuit.
- I. Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.
- J. Standards shall be plumb with arms aligned and square. Arms shall be perpendicular to the parking axis unless specifically shown otherwise.
- K. Standards shall be in line such that sighting along straight lines of standards will show no standard out of line with the others. The Contractor is cautioned that some curbs or roadway edges may not be straight and, therefore, should not be used for alignment.
- L. The Contractor shall erect the luminaires and pole assemblies complete on locations called out on the Drawings.
- M. The poles shall be installed with leveling nuts (galvanized). The space between the bottom of the pole base flange and the top of the footing shall be grouted to present a finished appearance with a 1/2" drain hole.

END OF SECTION