

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 – GENERAL

1.01 SUMMARY

- A. The intent of Division 26, Electrical Specifications and Drawings is to provide a complete and workable facility, with complete systems as required by applicable codes, as indicated, and as specified.
- B. Include work specified in Division 26, Electrical and as indicated on Drawings. Include appurtenances, connections, fasteners, and accessories required to make a complete working system, whether indicated or not indicated.
- C. Refer to Division 01, General Requirements.

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 26, Electrical

1.03 REFERENCES

- A. The latest adopted revisions of the publications listed below apply to these Specifications as referenced:
 - 1. IBC International Building Code
 - 2. NEC National Electrical Code
 - 3. NFPA National Fire Protection Association
 - 4. NEMA National Electrical Manufacturers Association
 - 5. NECA National Electrical Contractors Association
 - 6. ANSI American National Standards Institute
 - 7. IEEE Institute of Electrical and Electronic Engineers
 - 8. UL Underwriters Laboratories

1.04 SYSTEM DESCRIPTION

- A. Ground Systems:
 - 1. Provide complete ground systems indicated.
 - 2. Include conduit system, transformer housings, switchboard frame, and neutral bus, motors, and miscellaneous grounds required by Contract Documents and by applicable codes.
- B. System Identification:
 - 1. Clearly identify elements of the Project electrical system to indicate the loads served, or the function of each item of equipment, connected under this work.
 - 2. Comply with requirements of Division 26, Electrical, and with applicable codes.
- C. Drawings:
 - 1. Drawings are diagrammatic. They do not show every offset, bend, tee, or elbow, which may be required to install work in the space, provided and avoid conflicts with other construction.
 - a. Prior to installing work, take field dimensions, and note conditions available for, installation.

- b. Follow the Drawings as closely as practical to do so, and install additional bends, offsets, and elbows where required by installation conditions.
 - 1) Additional offsets, bends, and other connectors are subject to approval by Project Engineer.
 - 2) Install additional offsets, bends, and other connectors without additional cost to Owner.
- c. The right to make any reasonable changes in outlet location prior to roughing in is reserved to the Owner's Representative.
- 2. Luminaire Designations:
 - a. Lower case letters adjacent to devices or luminaires indicate switching arrangement or circuit grouping.
 - b. Numbers adjacent to devices indicate circuit connection.
- 3. Circuits and Switching:
 - a. Do not change branch circuiting and switching indicated; nor combine homeruns, without Engineer's prior approval.
 - b. Do not combine or change feeder runs.
- 4. Circuit Conductors:
 - a. Cross or hash marks on conduit runs indicate quantity of No. 12 copper branch circuit conductors, unless otherwise noted.
 - b. Where such marks do not appear, provide quantity of circuit conductors to the outlets shown to perform the control or circuiting indicated.
 - c. Include ground, travelers, and switch legs required by the circuiting arrangement indicated.
 - d. Provide a dedicated neutral conductor with each circuit. Do not use a shared neutral conductor between phases unless, requested or directed.

1.05 SUBMITTALS

- A. Comply with Division 01, General Requirements.
- B. Contractor Responsibilities:
 - 1. Submit submittals one time and in proper order.
 - 2. Ensure equipment will fit in the space provided.
 - 3. Deviations from the Drawings and Specifications specifically noted in the submittals. Failure to comply will automatically void any implied approval for use of the equipment on this project.
- C. Shop Drawings and Equipment Data:
 - 1. Combine electrical shop drawings and equipment data in Submittal binders.
 - 2. Include in Submittal binders:
 - a. Complete index of materials and equipment as required by Specifications to be documented by submittals.
 - b. Fully describe equipment furnish per manufacturer's detailed
 - c. All deviations from the Drawings and Specifications, noted on the submittals. Failure to comply will automatically void any implied approval for use of the equipment on this project.
- D. Installation Drawings:
 - 1. Submit prior to starting installation.

2. Show outlets, devices, terminal cabinets, conduits, wiring, and connections required for the complete system described.
- E. Record Drawings:
1. Keep record drawings up to date as the work progresses.
 2. Show changes, deviations, addendum items, change orders, corrections, and other variations from the Contract Drawings.
 3. Keep record drawings at the jobsite and available for the Architect's review.
 4. At the completion of the work, incorporate all deviations from the installation drawings to indicate as-built conditions.
 5. Description of system.
 6. Operating Sequence and Procedures:
 - a. Step-by-step procedure for system start-up, including a pre-start checklist.
 - 1) Refer to controls and indicators by nomenclature consistent with that used on panels and in control diagrams.
 - b. Detailed instruction in proper sequence, for each mode of operation (i.e., day-night, staging of equipment).
 - c. Emergency Operation:
 - 1) If some functions of the equipment can be operated while other functions are disabled, give instructions for operations under those conditions.
 - 2) Include here only those alternate methods of operations (from normal) which the operator can follow when there is a partial failure or malfunctioning of components or other unusual condition.
 - d. Shutdown Procedure:
 - 1) Include instructions for stopping and securing the equipment after operation.
 - 2) If a particular sequence is required, give step-by-step instructions in that order.
 7. Preventive Maintenance:
 - a. Schedule for preventive maintenance.
 - 1) State the recommended frequency of performance of each preventive maintenance task such as cleaning, inspection, and scheduled overhauls.
 - b. Cleaning: Provide instructions and schedules for all routine cleaning and inspection with recommended lubricants.
 - c. Inspection: If periodic inspection of equipment is required for operation, cleaning, or other reasons, indicate the items to be inspected and give the inspection criteria.
 - d. Provide instructions for lubrication and adjustments required for preventive maintenance routines. Identify test points and given values for each.
 8. Manufacturers' Brochures:
 - a. Include manufacturers' descriptive literature covering devices and equipment used in the system, together with illustrations, exploded views, and renewal parts lists.

- b. Clearly define manufacturers' standard brochures so that the information applying to the actual installed equipment.
- 9. Results of performance testing, as specified in PART 3 of this Section.
- F. Submittals Procedures:
 - 1. Review and recommendations by the Architect or Engineer are not to be construed as change authorizations.
 - 2. Either if discrepancies are discovered between the materials or equipment submitted, and the Contract Documents, prior to or after the data is processed, the Contract Documents govern.

1.06 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Products and equipment comply with Oregon Revised Statute (ORS) 453.005(7)(e) prohibiting pentabrominated, octabrominated, and decabrominated diphenyl ethers. Where products or equipment within this specification contains these banned substances, provide complying products and equipment from approved manufacturers with equal performance characteristics.
 - 2. Provide work and materials conforming to:
 - a. Local and State codes.
 - b. Federal and State laws and regulations.
 - c. Other applicable laws and regulations.
 - 3. Obtain and pay for all permits, licenses, and inspection certificates required by authorities having jurisdiction.
 - 4. Pay any other fees required by governing authorities for work of this Division.
- B. Install only electrical products listed by a recognized testing laboratory, or approved in writing by the local inspection authority as required by governing codes and ordinances.

1.07 SITE VISITATION

- A. Visit the site prior to bidding and become familiar with existing conditions and other factors which may affect the execution of the work. Complete coordination of installation of equipment with prior bid packages previously issued. Include related costs in the initial bid proposal.

1.08 COORDINATION

- A. Coordinate Work of This Division with all other trades to ensure proper installation of electrical equipment.
 - 1. Review Drawings of other trades or crafts to avoid conflicts with cabinets, counters, equipment, structural members, and other possible impediments to electrical work.
 - 2. Report potential conflicts to the Architect prior to rough-in.
 - 3. Proceed with rough-in following Architect's directives to resolve conflicts.
 - 4. Architectural Drawings govern.
- B. Verify the physical dimension of each item of electrical equipment to fit the available space. Contractor's responsibility includes:
 - 1. Coordination of the equipment to fit into the available space.
 - 2. Access routes through the construction.

- C. Layout Drawings:
 - 1. Equipment arrangement shown on Drawings is diagrammatic to indicate general equipment sizing and spatial relationship. Include, as part of distribution equipment submittal, a scaled floor plan, which includes equipment shown with their submitted sizes. Include all feeder conduit routing, both aboveground and underground, including termination points at equipment. Submit for Engineer's review prior to commencing work.
 - 2. Provide additional wiring details at switchboards, motor control centers, and other areas where work is of sufficient complexity to warrant additional detailing for coordination.
 - 3. Submit layout drawings for approval prior to commencing field installation.
- D. Where electrical connections are required for equipment provided as Work of other Divisions, coordinate rough in and wiring requirements for that equipment with its supplier and installer prior to commencing work. Notify Architect and Engineer of any discrepancies between the actual rough in and wiring requirements, and those identified on Drawings for resolution prior to installation.
- E. Arrange raceways, wiring, and equipment to permit ready access to switches, motors, and control components.
 - 1. Keep doors and access panels clear.
- F. Coordinate electrical, telephone, and other utility services with the appropriate serving utility.
 - 1. No additional compensation will be allowed the Contractor for connection fees or additional work or equipment required by the serving utility, but not covered in the Drawings or Specifications.
- G. Coordinate underground work with other contractors working on the site.
 - 1. Coordinate particularly with contractors installing storm sewer, sanitary sewer, water, and irrigation lines to avoid conflicts.
 - 2. Common trenches may be used with other trades, providing clearances required by codes and ordinances are maintained.

1.09 CHANGE ORDERS

- A. Supplemental cost proposals by the Contractor accompanied with a complete itemized breakdown of labor and materials. At the Architect's request, make available estimating sheets for the supplemental cost proposals. Separate and allocate labor for each item of work.

1.10 WARRANTY

- A. Provide a written warranty covering the work of this Division as required by the General Conditions.
 - 1. Incandescent Lamps: Excluded from this warranty.
- B. Apparatus:
 - 1. Free of defects of material and workmanship and in accord with the Contract Documents.
 - 2. Built and installed to deliver its full rated capacity at the efficiency for which it was designed.
 - 3. Operate at full capacity without objectionable noise or vibration.
- C. Include in Contractor's warranty for Work of Division 26, Electrical system damage caused by failures of any system component.

- D. General:
1. The electrical work of this project is complex in nature and has an inherent sequence, which may not be readily discernable.
 2. Provide a guide to the Contractor; the following construction sequence has been developed.
 3. This sequence is not necessarily all-inclusive, but work listed is within the project scope of work.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Where specified materials or methods conflict with applicable codes, the more stringent requirement applies.
- B. Provide apparatus built and installed to deliver its full rated capacity at the efficiency for which it was designed.
- C. Ensure that entire electrical system operates at full capacity without objectionable noise or vibration.
- D. Materials and Equipment:
1. Use materials and equipment that are:
 - a. New
 - b. Quality meeting or exceeding specified standards.
 - c. Free of faults and defects.
 - d. Conforming to Contract Documents.
 - e. Of size, make, type, and quality specified.
 - f. Suitable for the installation indicated.
 - g. Manufactured in accordance with NEMA, ANSI, UL, or other applicable standards.
 - h. Otherwise as specified in Division 01, General Requirements.
 2. Equipment not meeting all requirements will not be acceptable, even though specified by name.
 3. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer.
 - a. Component parts of the entire system need not be products of same manufacturer.
 4. Basis of Design:
 - a. Consider the Basis of Design equipment scheduled or specified by performance or model number.
 - b. If other equipment is provided in lieu of the Basis of Design equipment, assume responsibility for all changes and costs which may be necessary to accommodate this equipment, including, but not limited to:
 - 1) Different sizes and locations for connections.
 - 2) Different dimensions.
 - 3) Different access requirements.
 - 4) Other differences.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. General:
 - 1. Provide a complete properly operating system for each item of equipment specified.
 - 2. Install materials in a neat and professional manner.
 - 3. Comply with equipment manufacturer's written instructions, the best industry practices, and the Contract Documents.
 - 4. Comply with latest published NECA Standard of Installation, and provide competent supervision.
- B. Clarification:
 - 1. Where there is a conflict among manufacturer's instruction, best practice, and the Documents, request clarification from the Architect prior to rough-in.
 - 2. Architect's decision will be final.
 - 3. Remove and correct work installed without clarification at no cost to the Owner.
- C. Existing concrete, block, or brick walls are considered not accessible and may require use of Surface Mounted Raceway (SMR) if existing concealed raceway and device boxes are not available for reuse or do not meet the intent of the design (i.e., proximity to egress path, point of use, etc.). Coordinate route and installation where SMR is required with the Architect/Engineer prior to rough-in. Responsible for reinstalling SMR routed without such prior approval to the Architect's satisfaction.
- D. Existing stud walls (wood or metal) with or without blocking with plaster, plasterboard, or paneling finish are considered accessible with accessible ceiling, attic, tunnel, or crawl space above, below, or adjacent. Remove, patch, and repair finished surface as required to conceal rough in for new device locations. If it is determined that a specific instance will not permit concealment of rough-in due to obstructions such as beams, headers, and other structural elements, prior approval before rough-in from the Architect is required.

3.02 INSTALLATION IN RATED CONSTRUCTION

- A. Install intumescent material around ducts, conduits, and other electrical elements penetrating rated construction.
- B. Comply with firestop materials manufacturer written instructions to prevent spread of smoke or fire through sleeves or block-outs penetrating rated fire barriers.
- C. Provide firestop materials specified in Division 07, and as follows:
 - 1. Capable of passing a 3-hour test per ASTM E-814 (UL 1479).
 - 2. Consisting of material capable of expanding nominally eight times when exposed to temperatures of 250 degrees F-350 degrees F.
 - 3. An alternate method utilizing intumescent materials in caulk or putty complying with Division 07, Thermal and Moisture Protection Section, "Through-Penetration Firestop Systems" may be used.

3.03 NOISE CONTROL

- A. Minimize transmission of noise between occupied spaces.
- B. Outlet Boxes:
 - 1. Do not install outlet boxes on opposite sides of partitions back to back.
 - 2. Do not use straight through outlet boxes, except where indicated.

- C. Conduit:
 - 1. Route conduit along corridors or other “noncritical” space to minimize penetrations through sound rated walls, or through non-sound-rated partitions between occupied spaces.
 - 2. Grout solid and airtight all penetrations through sound rated partitions.
 - 3. Use flexible connections or attachments between independent wall structures.
 - a. Do not rigidly connect (i.e., bridge) independent wall structures.
- D. Do not install contactors, transformers, starters, and similar noise-producing devices on walls that are common to occupied spaces, unless otherwise indicated.
 - 1. Where such devices are indicated to be mounted on walls common to occupied spaces, use shock mounts, or otherwise isolate them to prevent the transmission of noise to the occupied spaces.
- E. 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.

3.04 EQUIPMENT CONNECTIONS

- A. General:
 - 1. 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.
 - 2. Verify the location and method for connecting to each item of equipment prior to roughing-in.
 - 3. Check the amperage, maximum overcurrent protection, voltage, phase, and similar attributes of each item of equipment before rough in and connection.
- B. Motor Connections:
 - 1. Make motor connections for the proper direction of rotation.
 - 2. Minimum Size Flex for Mechanical Equipment: 1/2-inch; except at small control devices where 3/8-inch flex may be used.
 - 3. Exposed Motor Wiring: Jacketed metallic flex with minimum 6-inches slack loop.
 - 4. Do not test run pump motors until liquid is in the system.
- C. Control devices and wiring relating to the HVAC systems are furnished and installed under Division 23, HVAC; except for provisions or items indicated in Division 26, Electrical Drawings and Specifications.

3.05 EQUIPMENT SUPPORT

- A. Minimum Support Capacity:
 - 1. Provide fastening devices and supports for electrical equipment, luminaires, panels, outlets, and cabinets capable of supporting not less than four times the ultimate weight of the object or objects fastened to or suspended from the building structure.
- B. Luminaire Supports:
 - 1. Support luminaires from the building structure.
 - 2. Use supports that provide proper alignment and leveling of luminaires.
 - 3. Where permitted at exposed luminaires, install flexible connections neat and straight, without excess slack, and attached to the support device.
- C. Support all junction boxes, pull boxes, or other conduit terminating housings located above the suspended ceiling from the floor above, roof, or penthouse floor structure to prevent sagging or swaying.

- D. Conduits:
 - 1. Support suspended conduits 1-inch and larger from the overhead structural system with metal ring or trapeze hangers and threaded steel rod having a safety factor of four.
 - 2. Conduits smaller than 1-inch installed in ceiling cavities, may be supported on the mechanical system supports when available space and support capacity has been coordinated with the subcontractor installing the supports.
 - 3. Anchor conduit installed in poured concrete to the steel reinforcing with No. 14 black iron wire.
- E. Powder actuated or similar shot-in fastening devices will not be permitted for any electrical work except by special permission from the Architect.

3.06 ACCESS DOORS

- A. Location and size of access doors is Work of Division 26, Electrical.
- B. Furnishing and installation of access doors is work of Division 08, Openings.

3.07 ALIGNMENT

- A. Install panels, cabinets, and equipment level and plumb, parallel with structural building lines.
- B. Install distribution equipment and electrical enclosures fitted neatly, without gaps, openings, or distortion.
- C. Properly and neatly, close unused openings with approved devices.
- D. Fit surface panels, devices, and outlets with neat, appropriate, trims, plates, or covers without overhanging edges, protruding corners, or raw edges.

3.08 CUTTING AND PATCHING

- A. General:
 - 1. Comply with Division 01, General Requirements.
 - 2. Restore to original condition new or existing work cut or damaged by installation, testing, and removal of electrical Work.
 - 3. Patch and finish spaces around conduits passing through floors and walls to match the adjacent construction, including painting or other finishes.
 - 4. Clean up and remove all dirt and debris.
- B. Make additional required openings by drilling or cutting. Use of jackhammer is prohibited.
- C. Cut oversize fill holes so that a tight fit is obtained around the objects passing through.
 - 1. In rated construction, comply with Division 07, Thermal and Moisture Protection.
- D. Obtain Architect's permission and direction prior to piercing beams or columns.
- E. Where alterations disturb lawns, paving, walks, and other permanent site improvements, repair and refinish surfaces to condition existing prior to commencement of work.

3.09 PROTECTION OF WORK

- A. Protect electrical work and equipment installed under this Division against damage by other trades, weather conditions, or any other causes.
 - 1. Equipment found damaged or in other than new condition will be rejected as defective.
- B. Keep switchgear, transformers, panels, luminaires, and electrical equipment covered or closed to exclude dust, dirt, and splashes of plaster, cement, paint, or other construction material spray.
 - 1. Equipment not free of contamination is not acceptable.

- C. Provide enclosures and trims in new condition, free of rust, scratches, and other finish defects.
 - 1. If damaged, properly refinish in a manner acceptable to the Architect.

3.10 UNINTERRUPTED SERVICE

- A. Maintain electrical service to all functioning portions of the building throughout construction.
- B. Pre-arrange with Owner outages necessary for new construction.
 - 1. Comply with Division 01, General Requirements.
 - 2. Apply for scheduled shutdowns minimum 4 weeks prior to time needed and reconfirm a minimum of 72 hours prior to time needed.
 - 3. Contractor is liable for any damages resulting from unscheduled outages or for those not confined to the pre-arranged times. Damages include costs incurred by the Owner and by the Owner's tenants.
- C. Maintain signal and communication systems and equipment in operation at all times.
 - 1. Outages of these systems shall be treated the same as electrical power outages.
- D. Maintain telephone services in accordance with Division 01, General Requirements.

3.11 DEMOLITION AND SALVAGE

- A. General:
 - 1. Remove or relocate all electrical wiring, equipment, luminaires, etc., as may be encountered in removed or remodeled areas in the existing construction affected by this work.
 - 2. Disconnect electrical service to hard-wired equipment scheduled for removal under other Divisions of Work.
 - 3. Wiring which serves usable existing outlets restored and routed clear of the construction or demolition.
 - 4. Safely cut off and terminate wiring abandoned and removed to leave site clean.
- B. Reuse of Existing:
 - 1. Existing concealed conduits in good condition may be reused for installation of new wiring where available.
 - 2. Existing undamaged, properly supported surface conduits may be reused where surface conduits are called for, if the installation meets all workmanship requirements of the Specifications.
 - 3. Where new wiring is added or existing wiring disturbed in existing branch circuit raceways, existing wires replaced with new.
- C. Salvage and Disposal:
 - 1. Removed materials, not containing hazardous waste, not scheduled for reuse shall become the property of the Contractor for removal from the site, except for those items specifically indicated on the Demolition Drawings for salvage or reuse.
 - 2. Materials containing, or possibly containing, hazardous waste identified for removal and disposal by the Owner's Hazardous Waste Contractor.
 - 3. Neatly store salvaged items at one location at the site where directed by the Owner's Representative.
 - 4. Salvage properly operating circuit breakers from panels scheduled for removal and use to replace faulty or inadequate breakers in existing panels scheduled to remain.

3.12 WIRING IN PRECAST CONSTRUCTION

- A. Coordinate installation of electrical conduit, boxes, fittings, anchors, and miscellaneous items concealed in precast concrete assemblies with the General Contractor.
- B. Where electrical items are required to be installed in concrete assemblies precast off-site, it will be the Electrical Contractor's responsibility to place the electrical items necessary in the concrete at the off-site locations or pay for the General Contractor to make arrangements for the installation of these items in the precast assemblies. Electrical Contractor held responsible for the proper placement and locations of electrical items at the off-site location.

3.13 COMPLETION AND TESTING

- A. General:
 - 1. Comply with Division 01, General Requirements.
- B. Upon completion, test systems to show that installed equipment operates as designed and specified, free of faults and unintentional grounds.
 - 1. Schedule system tests so that several occur on the same day.
 - 2. Coordinate testing schedule with construction phasing.
 - 3. Conduct tests in the presence of the Architect or its representative.
 - 4. Notify Architect of tests 48 hours in advance.
- C. Engage a journeyman electrician with required tools to conduct equipment tests. Arrange to have the equipment factory representative present for those tests where the manufacturer's warranty could be impacted by the absence of a factory representative.
- D. Perform tests per the requirements of each of the following systems:
 - 1. Fire Alarm System
- E. Provide a written record of performance tests and submit with operation and maintenance data.

END OF SECTION

SECTION 26 05 19

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Conductors - 600V
 - 2. Power Limited Wiring
 - 3. Conductors - Fire Pump Circuits
 - 4. MC Branch Circuit Cable
 - 5. Connectors - 600V and Below

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 26, Electrical
- C. Section 26 05 26, Grounding and Bonding for Electrical Systems
- D. Section 26 05 33, Raceways and Boxes for Electrical Systems
- E. Section 26 05 53, Identification for Electrical Systems

1.03 REFERENCED STANDARDS

- A. ASTM: American Society For Testing and Materials:
 - 1. ASTM B 3 Soft or Annealed Copper Wire
 - 2. ASTM B 8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - 3. ASTM B 33 Tinned Soft or Annealed Copper Wire for Electrical Purposes
- B. ICEA: Insulated Cable Engineers Association:
 - 1. S-95-658 Non-shielded 0-2 kV Cables
- C. IEEE: Institute of Electrical and Electronic Engineers:
 - 1. IEEE 383 Type Test of Class IE Electric Cables, Field Splices, and Connections
- D. UL: Underwriters Laboratories:
 - 1. UL 44 Rubber-Insulated Wires and Cables
 - 2. UL 83 Thermoplastic-Insulated Wires and Cables
 - 3. UL 1277 Type TC Power and Control Tray Cable

1.04 SUBMITTALS

- A. Submit product data for the following materials:
 - 1. Single conductor 600V power and control conductors.
 - 2. Fire Pump Cable
 - 3. MC Cable
- B. Submittals of the following materials consist only of a listing of the manufacturer's name and the applicable catalog numbers of the items to be utilized:
 - 1. Connectors
 - 2. Branch Circuit Conductor Splices
 - 3. Splices with Compression Fitting and Heat-Shrinkable Insulator

- C. Submit cable test data per testing requirements of PART 3.

1.05 QUALITY ASSURANCE

- A. Copper Conductors: Indicated sizes considered minimum for ampacities and voltage drop requirements.
- B. Conductors for special systems as recommended by the equipment manufacturer except as noted.
- C. Deliver conductors to the job site in cartons, protective covers, or on reels.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Conductors - 600V:
 - 1. General
 - 2. Essex
 - 3. Southwire
 - 4. Or approved equal.
- B. Conductors - Fire Pump Circuits:
 - 1. Pryotenax
- C. MC Branch Circuit Cable:
 - 1. AFC Cable Systems
 - 2. Southwire
 - 3. Okonite
- D. Connectors - 600V and Below:
 - 1. Burndy
 - 2. Anderson
 - 3. Or approved equal

2.02 CONDUCTORS – 600V

- A. Type:
 - 1. Copper: 12 AWG minimum size unless noted otherwise. 12 AWG and 10 AWG, solid or stranded, 8 AWG or larger, Class B concentric or compressed stranded.
 - 2. Aluminum: Not allowed.
 - 3. Conductors with continuous colored jackets are acceptable; refer to color-coding in PART 3.
 - 4. Conductors with manufacturers no lube continuous jacket coatings are acceptable.
- B. Insulation:
 - 1. THHN/THWN-2 for conductors 6 AWG and smaller.
- C. Thru wiring in fluorescent luminaires rated for 90 degree C minimum.

2.03 POWER LIMITED WIRING

- A. Copper, stranded or solid as recommended by the system manufacturer.
- B. Insulation appropriate for the system and location used.

2.04 MC BRANCH CIRCUIT CABLE

- A. Sheath:
 - 1. Steel or Aluminum, of the interlocking metal type, continuous and close fitting.
 - 2. Sheath not considered a current carrying or grounding conductor.

- B. Conductors:
 - 1. Solid copper, of the same ampacity as the conduit/wire system indicated for the specific location.
 - 2. Provide separate green insulated grounding conductors in circuits where an isolated ground is called for.
- C. Provide HCF rated cable for health care facility construction as code required.
- D. Feeder style MC Cable with steel or aluminum armor for feeders greater than 100A.

2.05 CONNECTORS – 600V AND BELOW

- A. Branch Circuit Conductor Splices:
 - 1. Twist-on wire connectors: 3M Insulated Electrical Spring Connector (312/512), Ideal Industries Wing-Nut, or Buchanan B-Cap.
- B. Cable Splices:
 - 1. Compression tool applied sleeves, Kearney, Burndy, or equivalent with 600V heat shrink insulation.
 - 2. Submit proposed splice location to the Engineer for review, except where indicated on the plans
- C. Terminator Lugs for Stranded Wire:
 - 1. 10 AWG Wire and Smaller: Spade flared, tool applied.
 - 2. 8 AWG Wire and Larger: Compression tool applied.
 - 3. Setscrew type terminator lugs furnished as an integral part of distribution equipment, switches and circuit breakers will be acceptable.

PART 3 – EXECUTION

3.01 CONDUCTORS

- A. Pulling compounds may be used for pulling conductors. Clean residue from the conductors and raceway entrances after the pull is made.
- B. Pulleys or Blocks:
 - 1. Use for alignment of the conductors when pulling.
 - 2. Pulling in accordance with manufacturer's specifications regarding pulling tensions, bending radii of the cable, and compounds.
- C. Make up and insulate wiring promptly after installation of conductors. Do not pull wire in until bushings are installed and raceways terminations are completed. Do not pull wire into conduit embedded in concrete until after the concrete poured and forms stripped.
- D. Provide a dedicated neutral conductor with each branch circuit, do not use a shared neutral conductor between phases unless specifically requested or directed.
- E. For remodel work or where shared neutrals are used by equipment such as systems furniture, provide a breaker handle tie as required for the phases sharing the neutral conductor.

3.02 MC CABLE

- A. Allowed only where concealed within wall or ceiling cavities.
- B. Do not use as branch circuit homeruns to branch panelboards.
- C. Terminate MC cabling within a local junction box and transition to conduit and building wire homerun back to panelboard within the room or as soon as possible.
- D. Locate junction box within one of the following spaces:
 - 1. Ceiling space
 - 2. Other accessible area of the room

- 3. Immediate area where MC cabling is servicing devices.
- E. EMT or RMC conduit utilized for branch circuit homeruns to branch panelboards.
- F. Provide enclosures and terminals to transition from MC Cable to building wire as required.

3.03 CONNECTORS

- A. Terminate control and special systems with a tool applied spade flared lug when terminating at a screw connection.
- B. Screw and bolt type connectors made up tight and retightened after an 8-hour period.
- C. Apply tool applied compression connectors per manufacturer's recommendations and physically checked for tightness.

3.04 COLOR CODING

- A. Color code secondary service, feeders, and branch circuit conductors. Phase color code to be consistent at feeder terminations, A-B-C left-to-right, A-B-C top-to-bottom, or A-B-C front-to-back. Color code is as follows:

120/240V 208Y/120V	Phase	480V 480Y/277V
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray*
Green	Ground**	Green
* or white with colored (other than green) tracer		
**Ground for isolated ground receptacles green with yellow tracer.		

- B. Use solid color compound or solid color coating for 12 AWG and 10 AWG branch circuit conductors and neutral sizes.
- C. Phase conductors 8 AWG and larger color code using one of the following:
 - 1. Solid color compound or solid color coating.
 - 2. Stripes, bands, or hash marks of color specified above.
 - 3. Colored as specified using 3/4-inch wide tape. Apply tape in half overlapping turns for a minimum of three inches for terminal points and in junction boxes, pull boxes, troughs, manholes, and handholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Apply tags to cable stating size and insulation type where cable markings are tape covered.
- D. Switch legs, travelers, etc., consistent with the phases to which, connected or a color distinctive from that listed.
- E. Color-coding of the flexible wiring system conductors and connectors.
- F. For modifications and additions to existing wiring systems, conform color-coding to the existing wiring system.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Ground Conductors
 - 2. Connectors

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 26, Electrical
- C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables
- D. Section 26 05 33, Raceways and Boxes for Electrical Systems
- E. Section 26 27 26, Wiring Devices

1.03 QUALITY ASSURANCE

- A. Provide complete ground systems as indicated. Include conduit system, transformer housings, switchboard frame and neutral bus, motors, and miscellaneous grounds required.
- B. Provide 600V insulated main bonding jumper for utility company connection between ground bus in switchgear lineup and ground termination point or service ground in transformer vault as directed by the utility.
- C. Provide an insulated ground conductor in every conduit or raceway containing power conductors.
- D. Continue existing system as specified herein and shown on the Drawings.

PART 2 – PRODUCTS

2.01 GROUND CONDUCTORS

- A. Green insulated copper for use in conduits, raceways, and enclosures.
- B. Bare copper for ground grids and grounding electrode systems.

2.02 CONNECTORS

- A. Cast, set screw, or bolted type.
- B. Form poured, exothermic welds.
- C. Grounding lugs where provided as standard manufacturer's items on equipment.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Grounding Conductors: Sized in accordance with Article 250, Tables 250.66 and 250.122 of the National Electrical Code.
- B. Grounding Conductor Connectors: Make up tight, located for future servicing, and ensure low impedance.
- C. Plug-in Receptacles: Bonded to the boxes, raceways, and grounding conductor.

3.02 EQUIPMENT

- A. Provide separate green insulated equipment ground conductor in non-metallic and flexible electrical raceways.
- B. Ground luminaires, panels, controls, motors, disconnect switches, exterior lighting standards, and noncurrent carrying metallic enclosures. Use bonding jumpers, grounding bushings, lugs, buses, etc., for this purpose.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Hangers
 - 2. Pipe Straps
 - 3. Support of Open Cabling

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 26, Electrical
- C. Section 26 05 33, Raceways and Boxes for Electrical Systems
- D. Section 26 50 00, Lighting

1.03 REFERENCED STANDARDS

- A. International Building Code (IBC)
- B. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

PART 2 – PRODUCTS

2.01 HANGERS

- A. Kindorf B-905-2A Channel, H-119-D washer, C105 strap, minimum 1/2-inch rod with ceiling flange, or approved equal.

2.02 PIPE STRAPS

- A. Two-hole galvanized or malleable iron.

2.03 SUPPORT OF OPEN CABLING

- A. Support of Open Cabling: Label NRTL for support of Category 16 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
 - 1. Support brackets with cable tie slots for fastening cable ties to brackets.
 - 2. Lacing bars, spools, J-hooks, and D-rings.
 - 3. Straps and other devices.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Provide electrical equipment supports.
- B. Install vertical support members for equipment, straight and parallel to building walls.
- C. Provide independent supports to structural member for electrical fixtures, materials, or equipment installed in or on ceiling, walls, or in void spaces and/or over furred or suspended ceilings.
- D. Do not use other trades' fastening devices to support electrical equipment materials or fixtures.
- E. Do not use supports and/or fastening devices to support other than one particular item.
- F. Support conduits within 18-inches of outlets, boxes, panels, cabinets, and deflections.

- G. Provide complete seismic anchorage and bracing for the vertical and lateral restraint of conduit, cable trays, bus ducts, and electrical equipment as required by IBC Chapter 6 and the most recent version of the SMACNA Seismic Restraint Manual for Seismic Hazard Level (SHL) A.
- H. Submit shop drawings of bracing systems to the Architect for review and bear the seal of a professional engineer registered in the State the project is located.

3.02 LUMINAIRES

- A. Light-Duty Ceiling Systems:
 - 1. Attach 12 gauge hanger wire from each corner of the luminaire to the structure above.
 - 2. Positively and securely, attach luminaire within 6-inches of each corner to the suspended ceiling-framing member by mechanical means.
- B. Intermediate-Duty Ceiling Systems:
 - 1. Positively and securely, attach luminaire within 6-inches of each corner to the suspended ceiling-framing member by mechanical means.
 - 2. Attach 12 gauge hanger wire within 3-inches of each corner of each luminaire.
 - 3. Connect two 12 gauge slack wires from the luminaire housing to the structure above for luminaires weighing less than 56 pounds.
 - 4. Support luminaires weighing 56 pounds or more directly from the structure above with approved hangers attached to each corner of the luminaire.
- C. Heavy-Duty Ceiling Systems:
 - 1. Positively and securely attach luminaire within 6 inches of each corner to the suspended ceiling-framing member by mechanical means.
 - 2. Connect two 12-gauge slack wires from the luminaire housing to the structure above for luminaires weighing less than 56 pounds.
 - 3. Support luminaires weighing 56 pounds or more directly from the structure above with approved hangers attached to each corner of the luminaire.

3.03 PULL AND JUNCTION BOXES

- A. Pull and junction boxes installed within the cavity of a suspended ceiling that is not a fire rated assembly may be attached to the suspended ceiling framing members, provided the following criteria are met:
 - 1. Installation complies with the ceiling system manufacturer's instructions.
 - 2. Pull or junction box is not larger than 100 cubic inches.
 - 3. Support to the main runner with two fastening devices designed for framing member application and positively attach or lock to the member.
 - 4. Serves branch circuits and associated equipment in the area.
 - 5. Pull or junction box is within 6-feet of the luminaires supplied.
 - 6. Framing members are not rotated more than 2 degrees after installation.
 - 7. Install within the cavity of a suspended ceiling may be attached to independent support wires, provided the following criteria are met:
 - a. Independent support wires are taut and connected at both ends, one end to the ceiling framing member and the other to the structure above.
 - b. Not larger than 100 cubic inches.
 - c. Secure to the independent support wires by two fastening devices designed for the application.

- d. Independent support wires in a fire-rated ceiling are distinguishable by color, tagging, or other effective means.

3.04 CABLES AND RACEWAY

- A. Cables and raceway installed within the cavity of a suspended ceiling may be attached to independent support wires provided the following criteria are met:
 - 1. Independent support wires are taut and connected at both ends, one end to the ceiling framing member and the other to the structure above.
 - 2. Raceways no larger than 1-inch trade size and cables and bundled cables are not larger than 1-inch diameter including insulation.
 - 3. Not more than three raceways or cables supported by independent support wire and supported within the top or bottom 12-inches.
 - 4. Cables for telecommunications, data processing, Class 2 power-limited signaling systems, fiber optics, and other power limited systems are securely fastened within 2 feet of each termination and at intervals not to exceed 5-feet or per the manufacturer's installation instructions.
 - 5. Secure raceways at intervals required for the type of raceway installed.
 - 6. Secure cables and raceway to independent support wires by fastening devices and clips designed for the purpose.
 - 7. Independent support wires are distinguishable by color, tagging, or other effective means.
- B. Cables and raceway installed within the cavity of a suspended ceiling may be supported with trapezes constructed of steel rods and channels provided the following criteria are met:
 - 1. The size of the rods, channel, and fastening devices are suitable for the anticipated weight.
 - 2. The spacing of the trapezes meets that required for the type of raceway installed.
 - 3. Secure to a trapeze by straps designed for the purpose.
 - 4. Cables and raceway do not support other raceway or cables.
 - 5. An appropriately sized seismic bracing system is installed.

END OF SECTION

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Metallic Conduits
 - 2. Non-Metallic Conduits
 - 3. Wireways
 - 4. Fittings
 - 5. Metallic Boxes
 - 6. Floor Boxes
 - 7. Non-Metallic Boxes

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 26, Electrical
- C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables
- D. Section 26 05 26, Grounding and Bonding for Electrical Systems
- E. Section 26 05 29, Hangers and Supports for Electrical Systems
- F. Section 26 05 53, Identification for Electrical Systems

PART 2 – PRODUCTS

2.01 GENERAL

- A. Raceways and conduits of specified types for electrical system wiring, except where clearly indicated otherwise.
- B. Fittings, boxes, hangers, and appurtenances required for the conduits and raceways.
- C. Size raceways and conduits as indicated. Where no size indicated, conduit may be the minimum code permitted size for the quantity of conductors installed, based upon NEC tables for conductors with type THW insulation.

2.02 METALLIC CONDUITS

- A. Rigid Metal Conduit (RMC):
 - 1. Smooth surfaced, heavy wall mild steel tube of uniform thickness and temper, reamed and threaded at each end and protected inside and out with galvanizing, sherardizing, or equivalent process.
 - 2. Comply with NEC Article 344.
- B. Intermediate Metallic Conduit (IMC):
 - 1. Smooth surface, intermediate wall mild steel tube of uniform thickness and temper, reamed and threaded at each end, and protected inside and out with galvanizing, sherardizing, or equivalent process.
 - 2. Comply with NEC Article 342.
- C. Electrical Metallic Tubing (EMT):
 - 1. Smooth surface, thin wall mild steel tube of uniform thickness and temper, galvanized or sherardized on the outside, and enameled on the interior.
 - 2. Comply with NEC Article 358.

- D. Flexible Conduits (Flex):
 - 1. Flexible Metallic Conduit:
 - a. Interlocking single strip steel construction, galvanized inside and out after fabrication.
 - b. Comply with NEC Article 348.
 - 2. Liquid Tight:
 - a. Similar to flexible metallic conduit, except encased in a liquid tight polyvinylchloride or equivalent outer jacket over the flexible steel core.
 - b. Comply with NEC Article 350.

2.03 WIREWAYS

- A. Troughs: Steel, painted, square in cross section, preformed knockouts on standard spacing, screw cover.
- B. Fittings: Tees, elbows, couplings as required for configuration shown on the Drawings.

2.04 FITTINGS

- A. RMC and IMC:
 - 1. Threaded Locknuts: Sealing type where used with NEMA 2, 3, 3R, 4, and 12 enclosures.
 - 2. Threaded Bushings: 1-1/4-inch and larger, insulated, grounding type as required under Section 26 05 26, Grounding and Bonding for Electrical Systems.
 - 3. Threaded Couplings:
 - a. Standard threaded of the same material and as furnished with conduit supplied.
 - b. Erickson type couplings may be used where required to complete conduit runs larger than 1-inch.
- B. EMT:
 - 1. Connectors:
 - a. Steel compression ring or steel set screw type for conduit termination, with insulated throat, suitable for conditions used.
 - b. Use lay-in grounding type bushings where terminating grounding conductors.
 - 2. Couplings: Steel compression ring or steel set screw type, concrete tight.
- C. Threadless: RMC and IMC couplings and box connectors may be steel threadless, compression ring or set screw type for use with conduits 1-inch and smaller where installed in poured concrete locations or where limited working space makes threaded fittings impractical.
- D. Weatherproof Connectors: Threaded
- E. Expansion Couplings: Equivalent to O.Z. type EX with jumper.
- F. Seal-Offs: With filler fiber, compound, and removable cover.

2.05 METALLIC BOXES

- A. Flush and Concealed Outlet Boxes: Galvanized stamped steel with screw ears for device ring mounting, knock-out plugs, mounting holes, fixture studs if required, RACO or equivalent.
- B. Surface Outlet Boxes: Galvanized stamped steel same as above for use on ceilings; cast steel or aluminum with threaded hubs or bosses for use on walls.

- C. Large Boxes:
 - 1. Boxes exceeding 4-11/16-inches when required welded steel construction with screw cover and painted, steel gauge as required by physical size.
 - 2. Manufacturers:
 - a. Hoffman
 - b. Circle AW
 - c. Or equivalent.
- D. Systems:
 - 1. Boxes for systems devices as recommended by the systems manufacturer, suitable for the equipment installed.
 - 2. Equip with grounding lugs, brackets, device rings, etc., as required.

2.06 FLOOR BOXES

- A. Large capacity combination concealed power, data, and communications services floor box with flush-hinged door and cover assembly. Nominal 12-inch by 10-inch by 3-inch stamped steel concrete tight box with four service compartments, multiple conduit entrances and pre-pour and after-pour adjusting screws. Cover to prevent water, dirt, and debris from entering the power and communication devices. UL listed for use with tile, carpet or wood floor finishes.
 - 1. Die cast aluminum cover and cable doors suitable for carpet or tile cut-ins.
 - 2. Black finish cover and carpet flange.
 - 3. Four steel service plates for power, signal and future devices.
 - 4. Provide an on-grade barrier pan with leveling feet and anchor points for slab on-grade applications.
 - 5. Wiremold RFB4-CI series or equal.

2.07 NON-METALLIC BOXES

- A. PVC, molded enclosures, threaded hubs.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Conceal conduits in finished spaces. Concealed conduits run in a direct line with long sweep bends and offsets. Where RMC and IMC embedded is in concrete below grade or in damp locations make watertight by painting the entire male thread with Rustoleum metal primer or equivalent before assembly.
- B. Route exposed conduit parallel or at right angles to structural building lines and neatly offset into boxes. Conduits attached directly to building surfaces closely follow the surfaces. Conduit fittings used to saddle under beams. Coordinate drilling or notching of existing beams, trusses on structural members with Architect prior to commencing.
- C. Rigidly secure RMC and IMC terminations at boxes, cabinets, and general wiring enclosures with double locknuts and bushings or approved fittings. Screw in conduit and engage at least five threads in hub where conduit boxes with threaded hubs or bosses are used. Use insulating bushings for conduits 1-1/4-inches or larger.
- D. Keep conduit and raceways closed with suitable plugs or caps during construction to prevent entrance of dirt, moisture, concrete, or foreign objects. Clean and dry raceways before installation of wire and at the time of acceptance.
- E. 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 moisture barriers.

3.02 CONDUIT

- A. RMC:
 - 1. Use in areas for wiring systems.
 - 2. Install for exposed runs of medium voltage circuits outside of the electrical rooms.
 - 3. Install where subject to mechanical injury.
 - 4. Install with threaded fittings made up tight.
- B. IMC:
 - 1. Use for medium voltage circuits where concealed or where exposed in the electrical rooms.
 - 2. Use for circuits rated 600V and less where not in contact with earth or fill.
 - 3. Install with threaded fittings made up tight.
- C. EMT:
 - 1. Use in other dry protected locations for circuits rated 600V and less.
 - 2. Securely support and fasten whether exposed or concealed at intervals of nominally every 8-feet and within 24-inches of each outlet, ell, fitting, panel, etc.
- D. Flex:
 - 1. Use for connections to vibration producing equipment and where installation flexibility is required with a minimum 12-inches slack connection.
 - 2. Limit flex length to 36-inches for exposed equipment connections and 72-inches in concealed ceiling and wall cavities.
 - 3. Use PVC jacketed flex in wet locations, areas subject to washdown, and exterior locations.

3.03 RACEWAYS

- A. Surface metal wireways may be installed at locations to serve motor starters or other control devices where required by a multitude of wiring interconnections or physical layout.

3.04 FITTINGS

- A. Assemble continuous and secured metallic raceways and conduits to boxes, panels, etc., with appropriate fittings to maintain electrical continuity. Cut square and reamed smooth conduit joints with fittings drawn up tight.
- B. Do not use Crimp-on, tap-on, indenter type, malleable iron, or cast set screw fittings.

3.05 BOXES

- A. General:
 - 1. Outlet Boxes: Code required size to accommodate wires, fittings, and devices.
 - 2. Provide multi-gang boxes as required to accept devices installed with no more than one device per gang.
 - 3. Equip metallic boxes with grounding provisions.
- B. Size and Type:
 - 1. Flush wall switch and receptacle outlets used with conduit systems 4-inches square, 1-1/2-inches or deeper, with one or two-gang plaster ring, mounted vertically. Where three or more devices are at one location, use one piece multiple gang tile box or gang box with suitable device ring.

2. Wall bracket and ceiling surface mounted luminaire outlets 4-inch octagon 1-1/2-inches deep with 3/8-inch fixture stud where required. Wall bracket outlets have single gang opening where required to accommodate luminaire canopy. Provide larger boxes or extension rings where quantity of wires installed requires more cubic capacity.
 3. Junction boxes installed in accessible ceiling or wall cavities or exposed in utility areas minimum of 4-inches square, 1-1/2 inches deep with appropriately marked blank cover.
 4. Boxes for the special systems suitable for the equipment installed. Coordinate size and type with the system supplier.
- C. Pull Boxes:
1. Provide pull boxes where shown for installation of cable supports or where required to limit the number of bends in conduits to not more than three 90-degree bends.
 2. Use galvanized boxes of code-required size with removable covers installed so that covers will be accessible after work is completed.
- D. Installation:
1. Mount boxes and outlets at nominal centerline heights shown on the drawings.
 2. Adjust heights in concrete masonry unit (CMU) walls to prevent devices or finish plates from spanning masonry joints.
 3. Recessed Boxes:
 - a. Flush with finished surfaces or not more than 1/8-inch back, level and plumb.
 - b. Long screws with spacers or shims for mounting devices will not be acceptable.
 - c. No combustible material exposed to wiring at outlets.
 4. Covers for flush mounted boxes in finished spaces extend a minimum of 1/4-inch beyond the box edge to provide a finished appearance. Finish edge of cover to match cover face.
 5. Boxes installed attached to a stud in sheet rock walls equipped with opposite side box supports equivalent to Caddy 760. Install drywall screw prior to finish taping. Methods used to attach boxes to studs not to cause projections on the face of the stud to prevent full-length contact of sheet rock to the stud face.

3.06 PULL WIRES

- A. Install nylon pull lines in empty conduits larger than 1-inch where routing includes 25-feet or more in length or includes 180 degrees or more in bends.
- B. Where conduits requiring pull lines are stubbed out and capped, coil a minimum of 36-inches of pull line and tape at termination of conduit for easy future access. Label pull lines as to conduit starting or terminations point and intended future use.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Labels

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 26, Electrical
- C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables
- D. Section 26 05 33, Raceways and Boxes for Electrical Systems
- E. Section 26 27 26, Wiring Devices
- F. Section 26 50 00, Lighting

PART 2 – PRODUCTS

2.01 LABELS

- A. Pre-printed:
 - 1. Permanent material pre-printed with black on white, with adhesive backing.
 - 2. Manufacturer:
 - a. Brady
 - b. 3M
 - c. Or equal.
- B. Engraved Laminated Plastic:
 - 1. 3-ply laminated plastic, colors indicated herein, with beveled edges, engraved letters, and stainless steel screw attachment.
 - 2. Nameplate length to suit engraving.
 - 3. Adhesive attachment is not acceptable.
- C. Clear Plastic Tape:
 - 1. Black (normal) or red (emergency or standby) 12 point Helvetica medium text, clear adhesive backing, field printed with proper equipment for device labeling.
 - 2. Manufacturers:
 - a. Brother P-Touch
 - b. Dyno-tape
 - c. Kroy
 - d. Or equal.
- D. Wire Markers:
 - 1. White with black numbers, adhesive-backed tape on dispenser roll.
 - 2. Manufacturers:
 - a. Brady
 - b. 3M
 - c. Or equal.
- E. Feeder Conduit Marking:
 - 1. Provide one-piece snap-around vinyl feeder conduit markers for feeder conduits.

2. Provide custom label, black letters on orange background indicating destination equipment, 1-1/4-inch high letters (minimum) – Seton Setmark Pipe Marker Series.
 3. Provide additional one-piece snap-around vinyl label, black letters on orange background for voltage designation (i.e., 277/480V, 120/208V).
 4. Secure labels to conduits using plastic tie wrap, two per label.
- F. Marker Pen: Black permanent marker suitable for writing on metallic surfaces.

PART 3 – EXECUTION

3.01 DEVICES

- A. Label each receptacle plate with preprinted clear plastic tape indicating serving panel and circuit number (e.g., PANEL 2PA-5). Clean oils, dirt, and foreign materials from plate prior to label application. Label receptacles connected to a GFCI protected circuit downstream from the protecting device.

3.02 RACEWAYS AND BOXES

- A. Label pull boxes and junction boxes for systems with paint or marker pen on box cover identifying system. Where box covers are exposed in finished areas, label inside of cover.
- B. Color label covers as follows:
- | | | |
|----|------------------|--------|
| 1. | 480Y/277V wiring | Orange |
| 2. | 208Y/120V wiring | Black |
| 3. | Fire Alarm | Red |
| 4. | Communications | Green |
| 5. | Security | Blue |
- C. Label each end of pull wires left in empty conduits with tags or tape indicating location of other end of wire.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Line Voltage Wall Switches
 - 2. Receptacles
 - 3. Plates

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 26, Electrical
- C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables
- D. Section 26 05 26, Grounding and Bonding for Electrical Systems
- E. Section 26 05 33, Raceways and Boxes for Electrical Systems
- F. Section 26 05 53, Identification for Electrical Systems

1.03 SUBMITTALS

- A. Product Data

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Line Voltage Wall Switches:
 - 1. Hubbell
 - 2. Leviton
 - 3. Arrow-Hart
 - 4. Pass & Seymour
- B. Receptacles:
 - 1. Use same manufacture as the Line Voltage Wall Switches.
 - 2. Hubbell
 - 3. Leviton
 - 4. Arrow-Hart
 - 5. Pass & Seymour
- C. Plates:
 - 1. Hubbell
 - 2. Leviton
 - 3. Arrow-Hart
 - 4. Pass & Seymour

2.02 MATERIALS

- A. Extra heavy duty grade wiring devices, with special devices as noted on the Drawings. Should the Drawings indicate a device other than those listed. Device of same grade and manufacture as specified below. Furnish a matching plug connector for special purpose devices that do not have the common 120V NEMA 5-20R configuration.

- B. Lighting switches and duplex receptacles installed have similar appearance characteristics unless noted otherwise.

2.03 LINE VOLTAGE WALL SWITCHES

- A. Line Voltage Switches:
 - 1. 20A rated, 277V, quiet type, extra heavy duty, heavy duty nylon toggle handle, back, and side wired with screw terminal connections.
 - 2. As noted on the drawings provide:
 - a. Pilot light switch: lighted clear toggle.
 - b. Momentary Contact Switches: 15A, SPDT, center off.
 - c. Key Switches: 20A, 277V, back and side wired with screw terminal connections.
- B. Except as noted herein, device exposed finish color as follows:
 - 1. Normal Power: Match existing finish.
 - 2. Emergency Power: Red

2.04 RECEPTACLES

- A. Standard Straight Blade Duplex Receptacle:
 - 1. 3-wire, 2-pole with grounding, extra heavy duty, 20A rated, NEMA 5-20R configuration, back and side wired with screw terminal connections.
 - a. Provide hospital grade in patient care areas as required by NEC.
 - b. Provide tamper-resistant as noted on the drawings or NEC required.
 - c. Provide isolated ground as noted on the drawings or NEC required.
 - d. Provide surge suppression receptacles as noted on the drawings.
 - 2. Ground Fault Interrupting straight blade duplex receptacle:
 - a. Heavy duty, 3-wire, 2 pole with grounding, self-testing, green "ON" LED to indicate power, red "ON" LED to indicate ground fault condition, 20A rated, NEMA 5-20R configuration, back and side wired with screw terminal connections.
 - 1) Provide hospital grade in patient care areas as required by NEC.
 - 2) Provide tamper-resistant as noted on the drawings or where NEC required.
 - 3) Provide weather-resistant rating at exterior locations as required by NEC.
- B. Clock Outlets: As noted on the drawings and compatible with the specified clock system.
- C. Special Purpose Receptacles: As noted on Drawings with NEMA configurations.
- D. Exposed Device Color, unless otherwise noted, is as follows:
 - 1. Normal power: Match existing.

2.05 PLATES

- A. Flush Finish Plates:
 - 1. Match existing.
- B. Surface Covers:
 - 1. Galvanized or cadmium plated steel, 1/2-inch raised industrial type with openings appropriate for device installed.

- C. Identification:
 - 1. Identify receptacle plates with a pre-printed label indicating serving panel and branch circuit number.
 - 2. Refer to Section 26 05 53, Identification for Electrical Systems.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Devices and finish plates installed plumb with building lines. Install wall mounted receptacles vertically at centerline height shown on the Drawings.
- B. Finish plates and devices are not installed until final painting is complete. Scratched or splattered finish plates and devices will not be accepted.
- C. Switches, receptacles and/or other devices ganged into a common enclosure provided with a separation barrier between devices where the combined circuit voltages within the enclosure exceeds 300V.
- D. Provide GFCI receptacles as shown on the drawings or as NEC required. Provide a GFCI type duplex receptacle in each required location, do not sub-feed normal receptacles downstream of the GFCI receptacle to obtain the GFCI rating.

3.02 CORD CAPS

- A. Special plugs provided with the receptacles given to the Owner in their cartons with a letter stating the date and the Owner's representative that received the materials.

3.03 COORDINATION

- A. Electrical Drawings indicate the approximate location of devices. Refer to Architectural elevations, sections, and details for exact locations.
- B. Coordinate with equipment installer the locations and methods of connection to devices mounted in cabinets, counters, work benches, service pedestals, and similar equipment.

3.04 TESTING

- A. Test receptacles for line to neutral, line to ground and neutral to ground faults. Correct defective wiring.

END OF SECTION

SECTION 26 50 00

LIGHTING

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Lenses
 - 2. Reflector Cones
 - 3. Housings
 - 4. Finish
 - 5. Suspension
 - 6. Lamps and Sockets
 - 7. Power Supplies
 - 8. Emergency LED Drivers
 - 9. Transformers
 - 10. Track Lighting Systems
 - 11. Custom Luminaires
 - 12. Exterior Luminaires
 - 13. Extra Material
 - 14. Disposal and Replacement

1.02 RELATED SECTIONS

- A. Division 01, General Requirements
- B. Division 26, Electrical
- C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables
- D. Section 26 05 26, Grounding and Bonding for Electrical Systems
- E. Section 26 27 26, Wiring Devices

1.03 DEFINITIONS

- A. BACNET Protocol for integration with BAS/BMS/EMS
- B. BAS Building Automation System
- C. BMS Building Management System
- D. EMS Energy Management System
- E. CCT Correlated Color Temperature
- F. CRI Color Rendering Index
- G. CS Control Station
- H. D Dimming Wall Switch
- I. DT Dual Technology (PIR + U)
- J. FC Footcandles
 - 1. The metric for measuring illuminance light levels
- K. GUI Graphic User Interface
- L. LCP Lighting Control Panel
- M. LED Light Emitting Diode
- N. LonWorks Protocol for integration with BAS/BMS/EMS

- O. MTBF Minimum Time Between Failures
 - 1. Total hours of testing / Number of failures
- P. OS/VS Occupancy Sensor / Vacancy Sensor,
 - 1. Occupancy sensors provide automatic on and automatic shut-off.
 - 2. Vacancy sensors provide automatic shut-off only, and require manual-on.
- Q. PC Photocell
- R. PIR Passive Infrared Technology
- S. Power Supply Ballasts and LED drivers
- T. RS RS-232 Connection for AV Integration
- U. SC Scene Control
- V. TC Timeclock, or astronomical timeclock
- W. U Ultrasonic Technology
- X. WS Wall Switch
- Y. WS/O Wallbox Occupancy Sensor Switch
 - 1. Wall Switch with integrated Occupancy Sensor

1.04 QUALITY ASSURANCE

- A. The lighting design for this project was based on luminaire types and manufacturers as specified.
- B. Basis of Design manufacturers are pre-qualified to bid on products where specified. Inclusion of manufacturer and product series does not relieve specified manufacturer from providing product as described in luminaire schedule; modifications to standard product, if required, include with initial bid.
- C. Alternate manufacturers listed in the Luminaire Schedule do not require prior approval but included with the shop drawing submittal. Inclusion of manufacturer and product series as an alternate does not relieve the manufacturer from providing product equivalent to the basis of design as described in luminaire schedule; modifications to standard product, if required, include with initial bid.
- D. Or Approved or Pre-Bid Approved Equal:
 - 1. Submit Substitution Request prior to bid, complying with requirements of Division 01, General Requirements.
 - 2. Approval determined by review of the following luminaire characteristics where applicable. Lack of pertinent data on characteristic constitutes justification for rejection of the submittal.
 - a. Performance:
 - 1) Distribution
 - 2) Utilization
 - 3) Average brightness/maximum brightness.
 - 4) Spacing to mounting height ratio.
 - 5) Visual comfort probability.
 - b. Construction:
 - 1) Engineering
 - 2) Workmanship
 - 3) Rigidity
 - 4) Permanence of materials and finishes.

- c. Installation Ease:
 - 1) Captive parts and captive hardware.
 - 2) Provision for leveling.
 - 3) Through-wiring ease.
- d. Maintenance:
 - 1) Relamping ease.
 - 2) Ease of replacement of ballast and lamp sockets.
- e. Appearance:
 - 1) Architectural integration.
 - 2) Light tightness.
 - 3) Neat, trim styling.
 - 4) Conformance with design intent.

1.05 GENERAL REQUIREMENTS

- A. Provide lighting outlets indicated on the Drawings with a luminaire of the type designated and appropriate for the location.
- B. Where a luminaire type designation has been omitted and cannot be determined by the Contractor, request a clarification from the Architect in writing and provide a suitable luminaire type as directed.
- C. Coordinate installation of luminaires with the ceiling installation and other trades to provide a total system that is neat and orderly in appearance.
- D. Luminaires located in fire rated assemblies rated for use in such assemblies or have assembly maintained by the installer through the use of appropriate construction techniques to maintain the assembly rating. It is the responsibility of the contractor to maintain the assembly rating and provide required components during construction. Coordinate luminaires impacted with Division 01, General Requirements, and life safety documents.
- E. Install remote power supplies and transformers in enclosures as required by luminaire specified. Locate remote power supplies and transformers as shown on drawings; where no location is shown, provide recommendation for approval prior to commencing field installation. Locate remote mounted power supplies and transformers within the distance limitations specified by the manufacturer.
- F. Exterior pole lights have an appropriated pole base as part of the assembly. For pole lights in pedestrian areas, use a flush pole base. Pole lights in parking areas a raised base used. Pole bases, footings, and structural components reviewed and approved by a state licensed structural engineer prior to ordering and installation.
- G. Linear lighting elements installed on building exterior, in coves, soffits, panels and other architectural materials are the longest sections available to meet the intent of the design and centered in the available space. Other items required to make the lights function installed out of site and coordinated with Architect, Landscape Architect, Lighting Designer and Electrical Engineer of Record. Transformers, drivers, and ballasts in suitable enclosures. Required connection points are the minimum box or connector available from the manufacturer. Standard electrical boxes are not allowed to produce linear runs in architectural coves. Ancillary material required is concealed from view. Coordinate final ceiling material, dimensions, and limitations with the ceiling manufacturer prior to ordering and installation.
- H. Coordinate voltage requirements to each luminaire as indicated on drawings.
- I. Verify luminaires carry a valid UL or ETL listing. Luminaires located in outdoor locations to carry and appropriate wet or damp listing as required for the mounting application.

- J. Procure luminaires through a distributor located within 200 miles of the project site with a valid business license in the state the project is located.
- K. Upon request of the Architect, Engineer, or Owner, provide back-up pricing in a unit cost breakdown per luminaire. Back-up pricing includes distributor net pricing, contractor net pricing, final owner pricing and mark-ups and discounts (lot price or all-or-none) associated with the luminaires.
- L. Lighting related change orders to include back-up pricing noted above for review by the Engineer and Lighting Designer.
- M. Provide manufacturer's warranty covering 5 years on drivers from date of purchase. Luminaire manufacture to operate driver at or below the required driver warranty temperature. Luminaire manufacturers failing to operate the driver, at the project required ambient temperature and within the driver manufacturer warranty parameters, will be responsible for driver warranty related costs over the warranty period.
- N. 80 percent of the luminaire material by weight at a minimum should be recyclable at end of life. Design luminaire for ease of component replacement and end-of-life disassembly.

1.06 SUBMITTALS

- A. Submit the following in accordance with Section 26 05 00, Common Work Results for Electrical:
 - 1. Shop Drawings, to include:
 - a. Product Data:
 - 1) Provide manufacturer's published product data information.
 - 2) This information is to be relevant to the specified product only.
 - 3) Submittals limited to not more than three sheets for each type specified.
 - 4) They are specifically not to have configurations available included for review.
 - 5) Submittals that contain information that is not relevant to the product specified will be rejected in total and resubmission will be required.
 - b. Luminaire dimensions on a fully dimensioned line drawing.
 - c. Lamp information, including array configuration:
 - 1) For LED lamps: proof of conformance with the following: ANSI C78.377-2015, IES LM 79-2008, IES LM 80-2008, IES LM 82-2012, IES LM 84-14, IES LM 85-14, IES TM 21-2011, IES TM 28-14 and special certifications required by the contract documents.
 - d. Lamp socket information.
 - e. Power supply and transformer information using ballast manufacturers published product data information. Multiple power supplies or transformers may be submitted for single luminaire if compatible with specification included in contract documents. Include certification of lamp and power supply and transformer compatibility for submitted.
 - f. Mounting details including clips, canopies, supports, and methods for attachment to structure. Provide equipment required for row configurations.
 - g. UL/ETL Labeling Information
 - h. Manufacturer's Warranty

- i. Photometric Reports consisting of the following:
 - 1) Candlepower distribution curves: Provide five plane candlepower distribution data at no more than 5 degree vertical angle increments.
 - 2) Coefficient of utilization table.
 - 3) Zonal lumen summary including overall luminaire efficiency.
 - 4) Luminaire luminance: Provide measured maximum brightness data for luminaires with reflectors and average brightness data for luminaires with refractors.
 - 5) Spacing to mounting height ratio. If parallel and perpendicular ratios differ, provide data on each plane.
 - 6) Pole information to include maximum supported effective projected area (EPA) and weight for the design wind speed, as well as structural calculations for each pole proposed.
 - 7) VCP calculations (where applicable): For general office lighting luminaires, provide typical VCP calculations for ceiling heights between 9-feet and 12-feet at 1-foot increments, for room sizes 20-feet by 20-feet and 30-feet by 30-feet.
 - j. Special requirements of the specification.
2. Operation and Maintenance Data:
- a. Prepare two copies of a Lighting Systems Maintenance Manual consisting of the following in a hard-cover binder for review. After review, Architect will deliver one copy to Owner. Manual to include:
 - 1) One complete set of final submittals of actual product installed, including product data and shop drawings. Include product data for actual power supply and transformer installed where applicable.
 - 2) List of lamps used in Project, cross-referenced to fixture types, with specific manufacturer's names and ordering codes.
 - 3) Re-lamping instructions for lamps that require special precautions (LED, tungsten halogen, metal halide, etc.).
 - 4) Lighting fixture cleaning instruction, including chemicals to be used or avoided.
 - 5) Parts list of major luminaire components and ordering information for replacement
 - 6) Copies of manufacturer warranties on product.
3. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.
4. Manufacturer's Installation Instructions:
- a. Indicate application conditions and limitations of use stipulated by product testing agency.
 - b. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
5. Closeout Submittals:
- a. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

- b. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- c. Maintenance Materials: Furnish for Owner's use in maintenance of project.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Luminaires new and complete with mounting accessories, junction boxes, trims, and lamps.
- B. Luminaire assemblies UL listed.
- C. Luminaires UL listed appropriate to mounting conditions and application.
- D. Install recessed luminaires in fire rated ceilings and use a fire rated protective cover thermally protected for this application and carry a fire rated listing.
- E. Luminaires installed under canopies, roofs, or open areas and similar damp or wet locations to be UL listed and labeled as suitable for damp or wet locations.

2.02 LENSES

- A. Mechanically secured from within the housing.
- B. Interior linear prisms with smooth exterior.
- C. Prismatic Acrylic:
 - 1. As specified in the Luminaire Schedule.
- D. Opal Acrylic:
 - 1. Extruded or injection molded of virgin acrylic plastic, 0.08-inch minimum overall thickness.
 - 2. As specified in the Luminaire Schedule.
- E. Opal Acrylic Overlay: High transmittance type, extruded of virgin acrylic plastic, 0.04-inch overall thickness, with minimum 80 percent light transmittance.

2.03 REFLECTOR CONES

- A. Spun of uniform gauge aluminum, free of spinning marks or other defects.
- B. Integral trim flange.
- C. Color and finish as specified in Luminaire Schedule.
- D. White Reflectors: Steel or aluminum, minimum 22 gauge, with hard baked white enamel finish with minimum 85 percent reflectance.
- E. Alzak Reflectors:
 - 1. Low iridescent sem-specular or as indicated in the luminaire schedule, Alzak or Coilzak with minimum reflectance of 90 percent.
 - 2. Supply luminaires using Alzak reflector cones by the same manufacturer unless directed otherwise in Luminaire Schedule.

2.04 HOUSINGS

- A. Dimensions: Proper for the various wattage noted on the plans and as recommended by the luminaire manufacturer or as specified in the luminaire schedule.
- B. Extruded Aluminum Housing:
 - 1. One piece housing of AA 6063 T5 extruded aluminum with 0.14 minimum thickness smooth and free of tooling lines in one uninterrupted section of 1-foot to 24-foot with the cross sectional dimensions as indicated in the Luminaire Schedule.

2. Section lengths as shown on the drawings and able to be transported into and out of the installation location after final construction without building demolition being required.
- C. Steel Housing:
1. 20 gauge minimum, free of dents, scratches, or other defects.
 2. Fill and sand exposed weld marks, joints, and seams smooth before finishing. Clean and dress edges to remove sharp edges or burrs.
 3. Section lengths as shown on the drawings comprised of 1-foot to 12-foot lengths.
- D. Sheet Metal Housings: Minimum 22 gauge cold-rolled steel, with welded joints. Exposed weld marks and seams filled and ground smooth.
- E. Door Frames for lensed luminaires: White painted, flat aluminum with mitered corners, spring assisted latches to hinge from either side.
- F. End Plates: Mechanical attach die cast end plates without exposed fasteners. End caps, minimum 0.125-inch thick.
- G. Provide an internal alignment spline where housing sections are joined together to form a continuous row.
- H. Recessed Luminaires:
1. Rated for use in recessed applications.
 2. If required by the owner or design team, provide test data proving the product is rated for use in recessed applications.
 3. Equip with through wire junction box. Box, power supply, and replaceable components accessible from the ceiling opening of the luminaire.
- I. Luminaires used as air-handling registers for HVAC systems meet the requirements of NFPA 90A.
- J. For wet and damp use, LED-based luminaire to be sealed, rated, and tested for appropriate environmental conditions and may not be accomplished by using an additional housing or enclosure

2.05 FINISH

- A. Visible surfaces to be of color and texture as directed in Luminaire Schedule.
1. Baked white dry polyester powder, if not specified, with a minimum average reflectance of 85 percent on exposed and light reflecting surfaces.
- B. Concealed interior and exterior luminaire surfaces to be Matte black or as recommended by the luminaire manufacturer.
- C. Prepare steel components for finishing with a 5-step zinc phosphating process prior to painting.
- D. Exposed aluminum surfaces:
1. Satin etched and anodized in the color as indicated in the Luminaire Schedule.
 2. Treat with an acid wash and clear water rinse prior to painting.
 3. Electrostatically paint or powder coat and oven bake in the color indicated in the Luminaire Schedule.
- E. Exposed steel surfaces:
1. Treat with acid wash and clear water rinse, then prime coat.
 2. Electrostatically paint or powder coat and oven bake in the color indicated in the Luminaire Schedule.

2.06 SUSPENSION

- A. Suspension Devices, type as specified in the Luminaire Schedule:
 - 1. Aircraft Cable:
 - a. Stainless steel type: 3/32-inch nominal diameter, stranded, with positive pressure, field adjustable clamp at fixture connection.
 - 2. Rigid Pendant:
 - a. 1/2-inch nominal diameter or as specifically shown on drawings.
 - b. Supplied by fixture manufacturer when available as standard product.
 - c. At fixture end of stems, provide earthquake type swivel fitting to permit 45 degree swing in any direction away from vertical.
 - d. Flat canopy to permit splice inspection after installation.
 - 3. Chain Hangers:
 - a. Length to suit fixture mounting height if shown or as field conditions dictate.
 - b. Use two heavy duty chains with S hooks at each suspension point.
 - c. Length to suit mounting height as shown on Drawings.
 - 4. Suspension system must permit $\pm 1/2$ -inch minimum vertical adjustment after installation.
- B. Supports:
 - 1. Provide internal safety cable from fixture body to structure.
 - 2. Carry fixture weight to structure and provide horizontal bracing from suspension points to ceiling framing to prevent sideways shifting. Provide diagonal seismic restraint wires per code.
- C. Feed Point:
 - 1. Flat-plate canopy to cover outlet box, with holes for support cable and power cord, concealed fasteners to permit splice inspection after installation.
 - 2. At the electrified connection provide straight cord feed. Provide a separate feed point where emergency feed is required.
 - 3. Power Cord: White multi-conductor cord, parallel to support cable (aircraft cable); within pendant (rigid pendant); or flexible conduit (chain hanger).
 - 4. Provide a separate fee point where emergency feed is required.
- D. Non-feed Points:
 - 1. 1/2-inch OD polished chrome end sleeve, inside threaded 1/4-inch-20, with 2 – inch diameter. Flat white plate to cover hole in ceiling. Top of cable with ball swaged on end, to fit inside sleeve.
 - 2. Provide support above ceiling as required.
- E. Suspension method allows adjustment to be made in hanging length to allow for variance in ceiling height.
- F. Exposed paintable suspension components have the same finish and color as the luminaire housing.

2.07 LAMPS AND SOCKETS

- A. Lamp each luminaire with the suitable lamp cataloged for the specific luminaire type and as indicated by the manufacturer, or as specifically indicated in the Luminaire Schedule, or as specified herein.
- B. Lamps to be field replaceable.

- C. Lamp sockets to be of configuration and design to accept standard LED lamps and circuit boards.
- D. LED lamps to meet or exceed 50,000 hours as defined by LM-80-08 based on both the ambient temperature listed and the LEDs B10L70 performance curve as published by the LED lamp manufacturer.
- E. LED lamps to be high brightness and proven quality from established and reputable LED manufacturers, including:
 - 1. Nichia
 - 2. Osram-SemiOpto
 - 3. Cree
 - 4. Philips Lumileds
 - 5. Seoul Semiconductor
 - 6. Bridgelux
 - 7. General Electric Gelcore
 - 8. Xicato
 - 9. Osram
- F. Replacement Lamps:
 - 1. Sorra
 - 2. Toshiba
- G. LED lamps that are integral into the housing; light bars, diodes, boards and other, to be rated and tested for use in the fixture specified and compatible with the driver tested and compatible with that fixture.
- H. Screw-In Base Replacement LED Lamps:
 - 1. Manufacturer to provide wattage restriction label on socket, equivalent to specified wattage on LED replacement lamp.
 - 2. LED replacement lamps not to be placed in air-tight enclosures or in insulated air tight (ICAT) rated luminaire enclosures without dedicated heat dissipation and thermal management of the luminaire system.
- I. Color Rendering Index (CRI):
 - 1. 80 or higher for ambient lighting in common spaces
 - 2. 90 or higher for accent lighting in common spaces
 - 3. 95 or higher for art lighting
 - 4. As indicated in the luminaire schedule
- J. Correlated Color Temperature (CCT) per luminaire schedule: Color consistency not to exceed a +/- tolerance of greater than two MacAdam Ellipses over the life of the luminaire.
- K. Adjustable Lamp Mechanisms: Include aiming stops which can be permanently set to position lamp vertically and rotationally.
- L. High power LED luminaire thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware
- M. Operating Temperature:
 - 1. -22 degrees F to 115 degrees F.
 - 2. Operate below manufacturer's published die junction temperatures when operated at 1W at 350 mA in an elevated ambient of 46 degrees C.

- N. Utilize quick-connect connections to replaceable boards to meet ANSI and UL/ETL and NEMA requirements.

2.08 POWER SUPPLIES

- A. UL recognized under the component program and modular for simple field replacement.
- B. Rate for use with the LED array specified:
 - 1. Warranty array and driver as an assembly.
 - 2. 5 year full replacement, non-pro-rated warranty is required on electronic components.
- C. Luminaires requiring more than one driver are not permitted, unless specified in the luminaire schedule.
- D. Power supplies used in enclosed and gasketed luminaires listed for use in wet locations, Type 1 construction.
- E. Rate for the expected ambient temperature in which they are installed.
 - 1. Exterior installed power supplies rated to start the lamps at 0 degrees F.
- F. Operate for a (+/- 10 percent) supply voltage of 120V through 277VAC at 60Hz.
- G. Power Factor: 0.9 minimum
- H. Lifetime minimum:
 - 1. 50,000 hours at full load and 77 degrees F ambient
 - 2. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
- I. Minimum time between failures (MTBF) greater than 300,000 hours at full load and 77 degrees F ambient, in accordance with MIL-HDBK-217.
- J. Driver and luminaire electronics deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10).
 - 1. Flicker index to be less than 5 percent at frequencies below 1000 Hz.
- K. Label systems using tandem wired luminaires be labeled accordingly. Locate label in the lamp compartment of each luminaire and identify the function of that luminaire. Do not make the label visible from room.
- L. Total Harmonic Distortion less than 20 percent and meet ANSI C82.11 maximum allowable THD requirements at full output. Imbalance current is not allowed to exceed full output THD at any point in the dimming curve.
- M. Meet or exceed 30mA2s at 277VAC for up to 50Ws of load and 75A at 240us at 277VAC for 100 watts of load.
- N. Withstand up to a 1,000V surge without impairment of performance as defined by ANSI C62.41 Category A.
- O. Housing have circuit diagrams and lamp connections applied thereto.
- P. Reduction of Hazardous Substances (RoHS) compliant.
- Q. Provide no light output when the analog control signal drops below 0.5 V, or the DALI/DMX digital signal calls for light to be extinguished and consume 0.5 watts or less in this standby. Control deadband between 0.5V and 0.65V included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.
- R. Support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
 - 1. Adjustment of forward LED voltage, supporting 3V through 55V.

2. Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA
 3. Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.
- S. Remote: Driver may be remote mounted up to 300-feet depending on power level and wire gauge.

2.09 EMERGENCY LED DRIVERS

- A. Consist of a high-temperature, replaceable maintenance-free nickel cadmium battery, integral charger, and electronic circuitry enclosed in single compact case. Provide solid-state charging indicator light to monitor the charger and battery, a double-pole test switch, and installation hardware.
- B. Emergency driver operates lamps for a minimum of 90 minutes in the emergency mode. Lumen output at end of 90 minutes, 60 percent of initial lumen output per UL924.
- C. UL listed for installation either inside or on top of the luminaire and be warranted for a full five years from date of installation.
- D. Install and wire by the luminaire manufacturer unless specified for field installation in the Luminaire Schedule.
- E. Wire as either Nightlight (always on) or switchable (with power failure sensing feed) as shown on the drawings.
- F. Mount in accordance with manufacturer's installation requirements.
- G. Initial lumen output to be full output of the luminaire rating.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Meet general requirements of NFPA 70, National Electric Code.
- B. Mounting heights specified on drawings:
 1. Wall Mounted luminaires: Centerline of luminaire.
 2. Pendant Mounted luminaires: Bottom of luminaire unless specifically identified in the Luminaire Schedule or on drawings.
- C. Support:
 1. Support by separate means from the building structure and not from the ceiling system, ductwork, piping, or other systems.
 2. Final decision as to adequacy of support and alignment will be given by the Architect.
- D. Power Supplies:
 1. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - a. Ambient temperature: -4 degrees to 122 degrees F.
 - b. Relative humidity: Maximum 90 percent, non-condensing.
 - c. Protected from dust and excess moisture during installation.
 2. Install per manufacturers prescribed methods.
 3. Located remote mounted power supplies and transformers within the distance limitations specified by the power supply manufacturer.
- E. Level luminaires, align in straight lines, and locate as shown on the architectural elevations and reflected ceiling plan.

- F. Manufacturer's labels or monograms not visible after luminaire is installed, but must be included for future reference.
- G. Recessed Luminaires:
 - 1. Trims which fit neatly and tightly to the surfaces in which they are installed without light leaks or gaps.
 - 2. Install heat resistant non-rubber gaskets to prevent light leaks or moisture from entering between luminaires trim and the surface to which they are mounted.
- H. Pole Luminaires:
 - 1. Provide cast-in-place concrete foundations for pole mounted luminaires.
 - 2. Concrete: As specified in Division 03, Concrete.
 - 3. Foundation Forms: As indicated.
 - 4. Place anchor bolts in foundation as recommended by manufacturer in the required bolt circle size.
 - 5. Tie reinforcing steel in foundation to the anchor bolts to form a solid cage.
 - 6. Tamp wet concrete during pouring to assure complete coverage below, around and within the cage and form.
 - 7. Hand finish top of foundation to produce a smooth, level surface.
 - 8. Provide a minimum 10-foot copper-clad steel ground rod at each pole base. Connect from ground rod to the ground lug in the pole with minimum AWG 8 copper conductor.
 - 9. Install pole mounted luminaires plumb with luminaires level, and with reflector distribution in the direction indicated in the Drawings.
 - a. Grout around the pole base at the foundation to close openings.
 - b. Install pole base cover over exposed installation hardware.
- I. Tungsten Halogen Lamps:
 - 1. Use silk gloves to insert lamps into luminaires.
 - 2. Do not energize luminaires during construction to prevent dust build up on lamp, socket and lamp chamber. Lamping occurs as last stage of construction.

3.02 COORDINATION OF WORK

- A. Architectural Reflected Ceiling Plans take preference as to the exact placement of the luminaires in the ceiling.
- B. Determine ceiling types in each area and provide suitable accessories and mounting frames where required for recessed luminaires. Luminaire catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a luminaire may be installed.

3.03 PROJECT CLOSEOUT

- A. Leave luminaires clean at the time of acceptance of the work. If luminaires are deemed dirty by the Architect at completion of the work, clean them at no additional cost. Protective plastic wrap is to be removed from parabolic luminaires just prior to owner acceptance.
- B. Provide fixtures with new lamps operating at time of final acceptance. Exception: For fluorescent dimming fixtures, provide minimum 100 hour/maximum 200 hour, continuously lit lamps or per ballast manufacturer's recommendations.
- C. Where incandescent lamps are used for construction lighting, replace the lamps with new lamps just prior to occupancy by the owner.

END OF SECTION