

SECTION 16010 – ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. General electrical requirements
 - 2. Temporary wiring, lighting and power
- B. These specifications are intended to provide for labor, materials, equipment, and services and of performing all operations required for the complete electrical system as specified herein and/or shown on the accompanying drawings.

1.3 SUBMITTALS

- A. Refer to Division 1 for Submittal Requirements. The following paragraphs are an extension of Division 1.
- B. Where names of manufacturers or catalog numbers are listed in the Specification and/or on the accompanying drawings it is to establish a standard for the type, general design and quality of the product required. Where "or approved equivalent" is indicated, other products similar in design and of equivalent quality and complying with the Drawings and Specifications will be considered for acceptance. See Division 1 Section "Product Substitutions". "Similar in design" and "equivalent quality" will be determined by the architect, engineer and lighting consultants.
- C. Any item not specified herein, but submitted as a substitute for the specified item, shall be submitted in accordance with Division 1 Section "Product Substitutions" and accompanied by manufacturer's documentation stating/illustrating the following applicable information in addition to the specific information requested in other sections:
 - 1. Dimensions/weight.
 - 2. Electrical ratings-voltage, amperage, short circuit capability, etc.
 - 3. Construction – gauge of steel/aluminum, paint finish/application method, color, NEMA type, etc.
 - 4. Warranty.
 - 5. Local manufacturer's representative or nearest stocking distributor.
 - 6. Length of time the product has been available to the public.
 - 7. Specific deviations.

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- D. Shop Drawings: Listed below are shop drawings required for submittal
1. Lighting Fixtures & Lamps
 2. Wiring Devices & Device Cover Plates
- E. Comments made on Shop Drawings during the review do not relieve the Contractor from compliance with requirements of the contract documents. Shop Drawings will be checked for general conformance with the design concept of the project and general compliance with the documents. Review of the Shop Drawings shall not relieve the Contractor from responsibility for conforming and correlating all quantities and dimensions, coordinating work with that of all other trades, and performing work in a safe and satisfactory manner. Review of Shop Drawings shall not permit any deviation from Drawings and Specifications. Shop Drawings must be accompanied by signed statement from Contractor, stating that he has reviewed the submittal and checked it for compliance.
- F. CLOSEOUT DRAWINGS:
1. Operation and Maintenance Manuals:
 - a. Before the date of substantial completion, Contractor shall furnish to the Architect three (3) bound sets of descriptive, dimensional and parts data on all major items of electrical equipment and material including those items listed above under "Shop Drawings".
 - b. Each set of this literature shall be bound in a permanent type hard cover ring binder and shall be suitably indexed.
 - c. This submittal shall be accompanied by test results for all tests required in other sections of the specification, final Electrical Inspection Certificate from the authority having jurisdiction and Statement of Inspection from State Fire Marshal's Office.
 2. Record Drawings:
 - a. Prepare Record Drawings in accordance with the requirements in Division 1.
 - b. In addition to the requirements specified in Division 1, indicate the following installed conditions:
 - 1) Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - 2) Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 - 3) Underground conduits both interior and exterior, drawn to scale and fully dimensioned.
 - 4) Grounding systems.
 - c. Transmit record drawings to Architect.

1.4 QUALITY ASSURANCE

- A. The electrical installation shall conform to the requirements of the latest edition of the National Electrical Code (NEC). Notify Architect of conflicts before installation.

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- B. Electrical material shall be built and tested in accordance with the applicable standards of the National Electrical Manufacturers' Association (NEMA), the American National Standards Institute (ANSI), the American Society for Testing and Materials (ASTM), and the Institute of Electrical and Electronic Engineers (IEEE).
- C. All applicable sections of the following codes and standards (latest edition) shall also be followed:
 - 1. NFPA, including but not limited to, NFPA 70 (NEC) and NFPA 101 (Life Safety Code).
 - 2. ADA (Americans with Disabilities Act)
 - 3. International Building Code (latest edition)
 - 4. Applicable state and local codes/ordinances.
 - 5. CBM – Certified Ballast Manufacturer.
 - 6. IPCEA – Insulated Power Cable Engineers' Association.
 - 7. FM – Factory Mutual.
 - 8. ETL – Electrical Testing Laboratories.
 - 9. IES – Illuminating Engineering Society.
- D. Include all items of labor and materials required to comply with the above referenced codes and standards. Where quantities, sizes, or other requirements indicated on Drawings or herein specified are in excess of the requirements of the Standards and Codes, the Specifications or Drawings shall govern. Where a conflict exists the more restrictive shall be bid.

1.5 COORDINATION

- A. Power Characteristics: For all items requiring power provided in sections of Division 2 through 15, the Contractor is to verify all electrical requirements, including voltages, ratings and any other electrical characteristics with actual equipment to be furnished and adjust work as required to provide proper electrical service to the particular item at no extra cost to owner. Notify the Architect before starting work if changes from the work shown on the drawings will be necessary.
- B. Coordination of Options and Substitutions: Where contract documents permit selection from several product options, do not proceed with purchasing until coordination of interface requirements has been checked and satisfactorily established.
- C. Raceways, Wiring, Safety/Disconnect Switches, etc. for Equipment by Others: Electrical service required for all equipment furnished under Division 15 (Mechanical), 16 (Electrical), or other Divisions of this Specification shall be furnished and connected as part of this work. It is part of the work of this Division to obtain correct roughing-in dimensions and requirements for this equipment and provide labor, materials, equipment and services for a complete installation.
- D. For exposed electrical work, coordinate colors and finishes with the Architect. Determine in advance of purchase that equipment and materials proposed for installation will fit into the confines indicated, leaving adequate clearance as required by applicable codes, and for adjustment, repair, or replacement.

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E. Coordinate location of access panels and doors for electrical items that are behind finishes surfaces or otherwise concealed.

F. MECHANICAL WORK:

1. Coordinate electrical work with mechanical work (Division 15) for proper service to each item of equipment requiring electrical connection prior to rough-in. Determine, with each mechanical equipment installer, the proper sequencing and location for disconnect switches and similar points of interface between mechanical and electrical work.
2. Except as otherwise indicated, final power connections are provided under Division 16 – Electrical.
3. Except as otherwise indicated, control wiring, 50 volts and less, and associated raceway system shall be provided under Division 15 - Mechanical.
4. Control wiring, 120 volts and above, and associated raceway systems shall be provided under Division 16 – Electrical.
5. Except as otherwise indicated, magnetic starters (excluding variable speed drives) shall be furnished under this Divisions. Variable speed drives are to be furnished and mounted under other division and connected under this division.
6. Overload elements in starters shall be selected according to actual motor nameplate full load current. Responsibility for this coordination shall lie with the Division under which the particular starter is furnished.
7. Except as otherwise indicated, power disconnect switches and single speed manual starting switches shall be furnished and installed under this Division. Where combination magnetic starters are provided as work of another Division, the associated disconnect switch will be furnished as work of that Division. Fuses shall be furnished and installed under this Division. Except as otherwise indicated, disconnect switches for control wiring shall be furnished and installed under Division 15- Mechanical.
8. Firestats for fans shall be furnished, installed and connected under Division 15 – Mechanical.
9. Determine location of control panel (DDC) for mechanical equipment & provide 120V circuit with a maximum of (3) control panels on each circuit.
10. Where a fire alarm system is provided, duct detectors for air handling units are to be provided under Division 16 – Electrical. Otherwise duct detectors shall be provided by Division 15 – Mechanical.
11. All conduits entering air moving HVAC equipment to be sealed with ductseal.

G. EQUIPMENT LAYOUT:

1. The physical location and arrangements of electrical equipment is shown on the plans and is to be used by the Contractor. Alternate arrangements due to field conditions or changes in physical size of the equipment proposed for the project are to be submitted to the Architect for review before any work is begun or equipment ordered. The alternate arrangement is to be presented in a 1/4 inch scaled drawing showing all equipment, including those of other contractors. Include shop drawing cut sheets and applicable information. Indicate on the drawing by dimension all required Code clearances, wiring distances and maintenance access requirements. Where equipment heights are required to be coordinated with architectural or other items, indicate revised heights.

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2. Where the design intent of the installation is not certain, ask for clarification. Lack of details will not be an excuse for improper installation. Any such work must be corrected at no expense to the Owner.
3. Coordination Drawings: For locations where several elements of the work must be sequenced and positioned with precision in order to fit into the available space, prepare coordination drawings showing the actual physical dimensions (at accurate scale, minimum ¼") required for the installation. At a minimum, prepare coordination drawings for every electrical room within the building, and for installation of raceways. Raceways shall be coordinated with other trades to avoid conflicts. Prepare and submit coordination drawings prior to purchase-fabrication-installation of any of the elements involved in the coordination.
4. Contractor shall be responsible to insure that equipment selected fits in spaces allocated, with provisions for maintenance and/or code required access and clearances.

H. DELIVERY, STORAGE AND HANDLING

1. The Contractor shall be responsible for receiving, unloading, storing, protecting from weather, theft, breakage, etc., all electrical equipment, and material either purchases by the Contractor or furnished by others. The Contractor shall remove such material from storage and transport it to the site of erection when required for construction. The Contractor shall protect his own tools in a like manner. Also, the Contractor shall protect all equipment from accidental damage due to operating and maintenance activities that will be in progress in the same area.
2. Storage Coordination: It is recognized that space at project for storage of materials and products is limited. Coordinate deliveries of electrical materials and products with scheduling and sequencing of work so that storage requirements at project are minimized. In general, do not deliver individual items of electrical equipment to project substantially ahead of time of installation.
3. At all times take precautions necessary to properly protect electrical equipment from damage. Failure to comply with the above to the Architect's satisfaction shall be sufficient cause for the rejection of the particular piece of apparatus in question.

1.6 PHASED CONSTRUCTION; SEQUENCING

- A. Refer to Division-1 provisions for determination of how construction phasing and sequencing requirements may affect performance of electrical work.

1.7 PERMITS, INSPECTIONS AND FEES

- A. Permits: Obtain and pay for all necessary permits, inspections, connection charges, fees, insurance, bond, licenses, and comply with all governing laws, ordinances, rules and regulations including those of the National Fire Protection Association and all municipal, state or other authority having jurisdiction over the work. Include all fees for services in bid.
- B. Certificates of Inspection: Upon completion and before the date of substantial completion of each designated Phase, furnish a certificate of inspection issued by the proper authorities to the effect that the installation is in full conformity with all local and state requirements.

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1.8 WARRANTY

- A. The Contractor shall guarantee the work installed by him for one year from the date of final acceptance of the project and shall furnish free of cost to the Owner materials and labor necessary to repair or replace defective items of workmanship. The Contractor shall guarantee all equipment to be of the quality and capacity specified.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Refer to DIVISION 1 sections for general requirements on products, materials and equipment. The provisions outlined below expand or modify the requirements as applicable to electrical work. Refer to other DIVISION 16 sections for additional requirements.
- B. Materials and equipment shall conform in all respects to the requirements set forth in these Specifications and the accompanying Drawings.
- C. Provide products which are compatible with other products of the electrical work and with other work requiring interface with the electrical work, including electrical connections and control devices. For exposed electrical work, coordinate colors and finishes with the Architect. Determine in advance of purchase that equipment and materials proposed for installation will fit into the confines indicated, leaving adequate clearance as required by applicable codes, and for adjustment, repair, or replacement. For concealed electrical work requiring access, provide access panel, complete with anchorages and hardware, of adequate size for intended access.
- D. All electrical products on this project shall conform, unless otherwise specifically noted, to applicable standards of the National Electrical Manufacturer's Association and shall be listed by the Underwriter's Laboratories, Inc.
- E. Where materials, equipment, apparatus, or other products are specified by manufacturer, brand name or type, or catalog number, such designation is to establish standards of desired quality and style and shall be the basis of the bid. Except where noted, it is implied that "or approved equal" follows all specified items.
- F. Any bills of materials, conduit and wire schedules, etc., shall be used for identification, type, and reference. It shall be the responsibility of the Contractor to determine exact quantities and components required to effect a complete job in accordance with drawings and associated specifications.
- G. Equipment shall be installed in strict accordance with manufacturer's instructions. Contractor shall obtain these instructions and they shall be considered a part of these specifications.

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PART 3 - EXECUTION

3.1 GENERAL

- A. Comply with all federal, state and local safety laws, ordinances and regulations relating to the building and public health and safety.
- B. No work shall be concealed until approved by the local inspector and all local regulations are adhered to.
- C. Electrical Drawings are diagrammatic except where dimensioned. Do not scale. Follow manufacturer's certified Shop Drawings for accuracy. Consult Architect in cases of doubt or conflict. Unless noted as fixed, dimensions are based on the product of one (1) manufacturer. Verify dimensions with certified Shop Drawings of the materials actually approved and purchased.

3.2 TEMPORARY WIRING, LIGHTING AND POWER AT THE SITE: Furnish and install provisions for temporary electrical service and construction light and power during the construction period conforming to all local code and State labor law requirements.

- A. Arrange for temporary service with St Tammany Parish Hospital.
- B. Furnish, install, and maintain all temporary service equipment as required until permanent service is installed and "alive", switch-over of temporary light system, for the building while under construction.
- C. Furnish, install, and maintain temporary feeders to exhaust fans utilized to achieve negative pressure in construction zone.
- D. Provide temporary panels, wires, conduits, etc. as required, to keep in operation the different building areas during construction. No additional compensation shall be provided to the Contractor to provide electrical power to all existing lights, receptacles, devices, HVAC equipment, etc., to keep these said areas in operation during construction.
- E. Refer to the Project Schedule for sequencing of the work. All electrical related services to and within the limits of work phasing areas not currently under construction, shall be maintained in complete functional operation. All electrical related work in areas designated by the work phasing plan to be under construction shall be made complete and functionally operable prior to proceeding with any other phase of the work.
- F. Remove all temporary electrical service equipment from the building when temporary services are no longer required.

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3.3 INSPECTION AND PREPARATION

- A. **Substrate Examination:** Installer of each element of electrical work shall examine condition of substrate to receive work, and conditions under which work will be performed, and shall make notification of conditions detrimental to completion of work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
- B. **Existing Facilities and Conditions:** The Contractor shall visit the building sites to determine existing conditions and will be held responsible for allowing for these conditions in his bid. This area of work may have existing storm drainage, mechanical and electrical utilities, etc. located underground. It is part of this work for the Contractor to determine the scope and location of all existing utilities and the scope and location of all new utilities to be installed concurrent with this project and arrange his work around others. Damages to existing utilities by the contractor shall be corrected by him at no additional compensation. Contractor shall call 1-800-272-3020 per Louisiana statutes.
- C. **Large and Heavy Equipment:** Where possible, prearrange for movement and positioning of large equipment into the building structure, so that enclosing walls and roofs will neither be delayed nor need to be removed. Otherwise, make notice of opening requirements to be maintained for subsequent entry of large equipment units.

3.4 CUTTING AND PATCHING

- A. **Structural Limitations:** Do not cut structural framing, walls, floors, decks and other members which are load bearing, except with the written consent of the Architect. Authorization will be granted only where there is no other reasonable method for completing electrical work, and where proposed cutting clearly does not materially weaken the structure.
- B. **Other Work:** Do not endanger or damage other work through procedures and processes of cutting to accommodate electrical work. Review proposed cutting with Installers of the work to be cut, and comply with their recommendations to minimize damage. Where necessary, engage original Installer or other specialists to execute cutting in recommended manner.
- C. **Patching:** Where patching is required to restore other work, because of cutting or other damage occurring during installation of electrical work, execute patching in manner recommended by original Installer. Original Installer, where patching of finishes existing prior to beginning of work, refers to those performing similar work in areas of new construction. Restore other work in every respect, including elimination of visual defects in exposed finishes, as judged by Architect.
- D. **Provide, properly located and sized, all required chases, shafts, openings, furred spaces, etc., required for the work or to conceal any of the work, in any part of the structure.**
- E. **It is the responsibility of this Division to coordinate with other responsible Divisions for required cutting and patching.**

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3.5 ELECTRICAL INSTALLATION

- A. Conform with arrangement indicated by contract documents, recognizing that portions of work are shown only in diagrammatic form.
- B. These specifications and accompanying drawings are intended to describe complete workable systems of the various types. Items of materials, work, or equipment not mentioned, but normally necessary for the proper execution of this work, shall be provided as if specifically called for.
- C. The drawings show approximate locations only of feeders, branch circuits, outlets, etc., except where specific routing or dimensions are indicated. The Architect reserves the right to make changes in locations indicated, before roughing-in, without additional cost to the Owner.
- D. Because of the small scale of the drawings, it is not possible to indicate all of the offsets, fittings, pull/junction boxes and accessories required. Investigate the structural and finish conditions and arrange work accordingly, furnishing fittings, bends, junction boxes, pull boxes, access panels, and accessories required to meet such conditions.
- E. Where coordination requirements conflict with individual system requirements, comply with the Architect's decision on resolution of conflict.
- F. Sequence, coordinate, and integrate various elements of electrical work so that electrical system will perform as indicated and be in harmony with other work of building. Architect will not supervise coordination, which is exclusive responsibility of Contractor.
- G. Arrange work to facilitate maintenance and repair or replacement of equipment. Locate services requiring maintenance on wiring devices and similar units in front of services requiring less maintenance. Connect equipment for ease of disconnecting, with minimum of interference with other work. Locate operating and control equipment and devices for easy access. Maintain NEC code working clearances around all electrical equipment.
- H. Install access panels where electrical work requiring access is concealed by finishes and similar work. Access panels utilized shall be approved by the Architect.
- I. Integrate electrical work in ceiling plenums, including lighting fixtures, with ceiling finish, suspension, ductwork, air diffusers and other work, so that required performances of each will be achieved.
- J. Where work is in close proximity to the work of other contractors, the Electrical Contractor shall review plans of other contractors and coordinate his work with theirs. The Electrical Contractor shall verify the location of lighting fixtures, beams, structural members, conduit, ductwork, pipes or other obstructions before beginning his work in the area. Notify the Architect where proper clearances do not occur or where the work of others would interfere with the safe and/or proper operation of this work. Give right-of-way in confined-service spaces to piping which must slope for drainage, and to larger HVAC ductwork and similar services which are less conformable than electrical services.

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- K. Fireproofing: Where conduit and/or cables penetrate fire-resistant/rated walls, partitions, ceilings, or floors, adequate fire seals using UL listed methods and products listed for the application to maintain the fire-resistance rating shall be provided and installed.

3.6 MOUNTING HEIGHTS

- A. Refer to Architectural elevations for mounting height of all devices on the drawings. If devices is not indicated on the Architectural elevations than the following mounting heights shall apply. Heights are to center of device unless noted otherwise:

Toggle Switches	4'-0"
Receptacles	1'-6"
Telephone/Data Outlets	1'-6"
Cable TV Outlets	1'-6"
Motor Control Equipment	5'-0"
Fire Alarm Manual Pull Stations	4'-0" to top
Fire Alarm Visual, Audible, and Audible/Visual Alarm Indicating Devices	80" above floor or 6" below the ceiling; whichever is the lower to the bottom of the appliance
Panelboards	6'-6" to top (not more than 5'-6" from top most operating handling to floor.)
Contactors/Time Switches	5'-0"
Clock	7'-0"

- B. Upon approval of the Architect, mounting heights may be adjusted to simplify cutting of concrete blocks in block walls or to facilitate furniture, base or cabinet arrangements. All mounting heights may be field adjusted by the Architect without any additional cost.
- C. Coordinate mounting height of wiring devices above counters and/or benches and/or shelves and/or lavatories with architect prior to rough-in.

3.7 SERVICE CONTINUITY

- A. At all times during the construction of the project, services (power, telephone, fire alarm, etc.) shall be maintained to all portions of the site except with prior written approval of interruptions. Any required interruptions of services (power, telephone, fire alarm, etc.) due to work being performed under this contract shall be scheduled in advance after consultation with the Architect and the Owner.
- B. At least 14 days prior to the requirement of any interruption of services, the Contractor shall furnish to the Architect for approval a written plan for the work associated with the outage including a description of the installation and removal of temporary wiring and facilities necessary to be installed.

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3.8 ACCESS TO ELECTRICAL WORK

- A. Install access units in accordance with manufacturer's written instructions, in compliance with NEC, and with recognized industry practices.
- B. Coordinate with other work, including substrate construction work, as necessary to interface installation of access units with other work.
- C. Locate each removable access unit accurately in relation to electrical work requiring access.
- D. Provide adequate temporary support or attachment to framing or formwork so that units will not be dislocated during construction of substrates.
- E. Set frames accurately in position and securely attach to supports with face panels plumb or level in relation to adjacent finish surfaces.
- F. Adjust hardware and panels after installation for proper operation.
- G. Remove and replace panels or frames which are warped, bowed, or damaged.

3.9 WORKMANSHIP

- A. All workmanship shall be of the highest quality. Any work judged substandard by the Architect shall be redone at the Contractors expense. Install all materials and electrical components of the work in accordance with instructions of manufacturer following the best modern construction practices and conforming with the Contract Documents. Workmanship shall be first class, in both function and appearance, whether finally concealed or exposed and shall be performed by experienced workmen skilled in the type of work. As practicable, the lines of all components of the system shall be perpendicular or parallel to building lines. In general, workmanship shall conform to guidelines set forth in N.E.C.A. manuals.

3.10 FIELD QUALITY CONTROL

- A. As a minimum, upon completion of installation of electrical connections, and after circuitry has been energized, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement.

3.11 CLEANING UP

- A. Remove once per week and at the completion of the work all empty cartons, scrap wire, raceways, rubbish, etc., accumulated on the project as a result of work performed.
- B. Remove all marks, stains, fingerprints, bugs, dust and other foreign material from all electrical components. Refinish damaged surfaces and restore original finish to the satisfaction of the Architect.

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C. After final performance test run of each electrical system, clean system both externally and internally. Touch-up minor damage to factory-painted finishes; refinish work where damage is extensive.

D. Construction Equipment: After completion of performance testing and Owner's operating instructions and demonstrations, remove installer's tools, test facilities, construction equipment and similar devices and materials used in execution of work but not incorporated in work.

3.12 **SAFETY:** It shall be the Contractor's responsibility to do all things necessary in the pursuit of the installation or testing to provide safe conditions in which to work.

END OF SECTION 16010

SECTION 16020 – ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes:
 - 1. Demolition and removal of selected electrical portions of building or structure.
 - 2. Demolition and removal of selected electrical site elements.
 - 3. Salvage of existing electrical items to be reused or recycled.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction and deliver them to Owner.
- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 SUBMITTALS

- A. Pre-demolition Photographs or Videotapes: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolition operations. Comply with Division 1 Section "Photographic Documentation." Submit before Work begins.

1.5 PROJECT CONDITIONS

- A. Hazardous Materials: It is unknown whether hazardous materials will be encountered in the Work.

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1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Owner will remove hazardous materials under a separate contract.

- B. Storage or sale of removed items or materials on-site is not permitted.

1.6 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Field measurements and circuiting shown on drawings is based on casual field observation and existing record documents, and may not reflect actual conditions. Verify field measurements and existing circuiting prior to work, and report discrepancies to Architect/Engineer before disturbing existing installation.
- B. Verify that wiring and equipment to be disconnected serve only abandoned facilities not required to remain.
- C. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs or preconstruction videotapes.
 1. Comply with requirements specified in Division 1.
 2. Before selective demolition or removal of existing building elements, make permanent record of measurements, materials, and construction details.

3.2 PREPARATION

- A. Disconnect electrical systems noted for removal.
- B. Coordinate service outages for power, telephone, fire alarm, etc with Owner.

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- C. Provide temporary wiring and connections to maintain existing systems in service during construction.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove all abandoned wiring to source of supply.
- B. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut abandoned conduit flush with existing walls and floors to remain, and patch surfaces.
- C. Where electrical items (i.e. conduits, boxes, wiring, etc) are required to remain in areas of new construction, and interfere with the new construction, relocate those items as required to avoid the new construction.
- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlet box if conduit servicing the box is abandoned and removed. Provide blank cover for abandoned outlet boxes which are not removed.
- E. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers, and other accessories.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.
- G. For items noted to be removed on the drawings, remove associated existing wiring and conduits not required to be re-used. Re-feed any items fed through removed items as required with new circuiting to match existing. Field verify and adjust demolition as required to accommodate actual existing circuiting arrangement.
- H. Coordinate exact scope of demolition with Architect and disconnect and remove additional items if required, whether specifically shown on drawings or not.
- I. Do not re-use any conductors removed from existing conduits runs.
- J. Removed and Reinstalled Items:
 - 1. Clean and repair items to functional condition adequate for intended reuse.
 - 2. Protect items from damage during transport and storage.
 - 3. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- K. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

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- L. The temporary feed from the mechanical building to the construction elevator is to be removed at the end of the project. This is to include the cable, the disconnect switch, protective devices, hangers and anything else used for the temporary services. Grass area is to be restored to its original condition.

3.4 SALVAGED MATERIAL

- A. **Removed and Salvaged Items:** The Owner shall have priority for the selection of salvaged material and equipment. Any equipment and material selected to remain the property of the Owner shall be removed and delivered to a location on the site as designated by the Owner. Material and equipment not retained by the Owner shall become the property of the Contractor and shall be removed from the site by him.

3.5 DISPOSAL OF DEMOLISHED MATERIALS

- A. **General:** Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 4. Comply with requirements specified in Division 1.
- B. **Burning:** Do not burn demolished materials.
- C. **Disposal:** Transport demolished materials off Owner's property and legally dispose of them.

3.6 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 16020

SECTION 16060 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section includes methods and materials for grounding systems and equipment. Grounding requirements specified in this section may be supplemented by special requirements of systems described in other sections.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

SECTION 16060 - GROUNDING AND BONDING

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Equipment Grounding Conductors: Insulated with green colored insulation.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits. Conduit system will not be accepted as the only means of grounding for feeders or branch circuits.
- B. Install insulated equipment grounding conductors with all of the feeders and branch circuits as part of the redundant grounding system required per NEC 517-13
- C. Conduit system is to be constructed as a complete grounding system per NEC 517-13.
- D. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a non metallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from junction box. Terminate at equipment grounding conductor terminal of the applicable derived system unless otherwise indicated.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

SECTION 16060 - GROUNDING AND BONDING

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- C. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

3.4 CONNECTIONS

- A. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- B. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- D. Continuity of the building equipment grounding system shall be maintained throughout the project. Grounding jumpers shall be installed across conduit expansion fittings, all liquid-tight flexible metal and flexible metal conduits, light fixture pigtails in excess of 6", and all other non-electrically continuous raceway fittings.
- E. Grounding of all motors or equipment connected to terminal box with flexible conduit shall be made with separate grounding conductor between motor frame or equipment cabinet or rigid conduit system. Grounding conductor shall be sized in accordance with table 250-95 of the NEC.
- F. All grounding conductors shall be amply protected from mechanical injury and shall be supported in an approved manner. Where conductors are located in concrete, they shall be installed in conduit. Where ground conductors enter or emerge from slabs bearing directly on fill or soil, the voids between the conductor and surrounding conduit shall be filled with compound to provide an effective water seal.

3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:

SECTION 16060 - GROUNDING AND BONDING

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at service disconnect grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Grounding system will be considered defective if it does not pass tests and inspections.

END OF SECTION 16060

SECTION 16073 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

SECTION 16073 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 4. Channel Dimensions: Selected for applicable load criteria.
 5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.

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- 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggie Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

2.3 MATERIALS: SUPPORTS AND ALL COMPONENTS

- A. Indoor (Dry): Galvanized steel.
- B. Indoor (Wet): Stainless steel.
- C. Outdoor, above grade: Stainless steel.
- D. Outdoor, below grade: Non-metallic with stainless steel hardware.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

SECTION 16073 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

SECTION 16073 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.
- C. Install hangers, anchors, sleeves and seals, in accordance with manufacture's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA, NEC and ANSI/NEMA for installations of supporting devices.
- D. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- E. Install hangers, supports, clamps and attachments to support conduit properly from building structure. Arrange for grouping of parallel runs of horizontal to be supported together on trapeze type hangers where possible.
- F. Groups of three or more conduits shall be supported by metallic slotted support system and threaded hanger rods. Wire hangers and conduit as supports will not be acceptable.
- G. Support all equipment covered by this specification directly from building structural members independent of any ceiling or any other installed item. Panelboards and switches may be attached to suitably reinforced walls. Ground or slab mounted equipment shall be mounted on a separate four inch high concrete housekeeping steel reinforced slab.
- H. Do not attach items of this specification to HVAC ductwork, ceiling grids and ceiling support members, piping or other equipment unless specifically shown otherwise. Position all supports and equipment such that access through lay-in ceilings or panels is not impaired and all Code required clearances are maintained.
- I. Where applicable, under no circumstances is the Electrical Contractor to attach to support from any bar joist bridging. Any supports to the bar joists or any structural systems are to be approved by the Architect.
- J. Wire shall not be used with or without spring steel fasteners, clips, or clamps for the support of any conduit. Wood products shall not be used for the support or attachment of conduit or electrical equipment unless specifically noted otherwise.

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

SECTION 16073 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 16073

SECTION 16075 - ELECTRICAL IDENTIFICATION

SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification for conductors.
 - 3. Equipment identification labels.
 - 4. Miscellaneous identification products.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Equipment connected to normal power to be white letters on a black background. Equipment connected to emergency power to be white letters on red background. Minimum letter height shall be 3/8 inch.

2.2 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F.
 - 5. Color: Black.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 9 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- B. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- C. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- D. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
- E. Painted Identification: Comply with requirements in Division 9 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch-wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:
 - 1. Directly to conduit.
- B. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive vinyl labels. Install labels at 10-foot maximum intervals.
- C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Panel Name.
 - 2. Circuit Number.
- D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

SECTION 16075 - ELECTRICAL IDENTIFICATION

- a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral: Gray.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
 - e. Green colored tape shall only be used for equipment grounding conductors.
 - f. The HI-leg on a 120/240v-3ph system shall have orange color per NEC.
- E. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.
- F. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.
- 1. Comply with 29 CFR 1910.145.
 - 2. Apply to exterior of door, cover, or other access.
 - 3. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
 - c. Elevator controllers.

SECTION 16075 - ELECTRICAL IDENTIFICATION

- I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 2. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
 - b. Access doors and panels for concealed electrical items.
 - c. Emergency system boxes and enclosures.
 - d. Enclosed switches.
 - e. Inverter equipment.

END OF SECTION 16075

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SECTION 16120 - CONDUCTORS AND CABLES

SECTION 16120 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.5 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. American Insulated Wire Corp.; a Leviton Company.

SECTION 16120 - CONDUCTORS AND CABLES

2. General Cable Corporation.
3. Senator Wire & Cable Company.
4. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

D. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC; mineral-insulated, metal-sheathed cable, Type MI; nonmetallic, Type NM; Type SO and Type USE with ground wire.

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Minimum size: Minimum conductor size for power and lighting circuits shall be No. 12 AWG.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.

C. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

D. Class 1 Control Circuits: Type THHN-THWN, in raceway.

SECTION 16120 - CONDUCTORS AND CABLES

- E. Class 2 Control Circuits: Type THHN-THWN, in raceway, unless indicated otherwise.
- F. Fire Alarm Circuits: Power limited, Fire-protective, signaling circuit cable in raceway, unless indicated otherwise.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Install cables in raceways, concealed in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- D. Identify and color-code conductors and cables.
- E. No more than three phase conductors, three neutrals and ground shall be installed in any raceway unless specifically shown on the drawings.
- F. Conductors for 20A branch circuiting of 120V, more than 75 feet long, (to the first fixture or other current-consuming outlet), and of 277V, more than 150 feet long (to the first fixture or other current consuming outlet) shall be No. 10 AWG, unless larger size indicated on drawings.
- G. Conductors connected to the emergency system shall be installed in a separate conduit system from conductors connected to the normal system.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.

SECTION 16120 - CONDUCTORS AND CABLES

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: Perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
 - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 16120

SECTION 16130 - RACEWAYS AND BOXES

SECTION 16130 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible nonmetallic conduit.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

SECTION 16130 - RACEWAYS AND BOXES

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
 2. Afflex Inc.
 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 5. Electri-Flex Co.
 6. Manhattan/CDT/Cole-Flex.
 7. Maverick Tube Corporation.
 8. O-Z Gedney; a unit of General Signal.
 9. Wheatland Tube Company.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Aluminum Rigid Conduit: ANSI C80.5.
- D. IMC: ANSI C80.6.
- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
1. Comply with NEMA RN 1.
 2. Coating Thickness: 0.040 inch, minimum.
- F. EMT: ANSI C80.3.
- G. FMC: Zinc-coated steel or aluminum.
- H. LFMC: Flexible steel conduit with PVC jacket.
- I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 2. Fittings for EMT: Steel or die-cast, compression type.
 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

SECTION 16130 - RACEWAYS AND BOXES

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corp.; Pipe & Plastics Group.
6. Condux International, Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; a Hubbell Company.
12. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

D. LFNC: UL 1660.

E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: UL 514B.

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Arnco Corporation.
2. Endot Industries Inc.
3. IPEX Inc.
4. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible type, approved for type of installation.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).

SECTION 16130 - RACEWAYS AND BOXES

13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Plastic.
- H. Cabinets:
 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 1. Exposed Conduit: Rigid steel conduit, IMC.
 2. Concealed Conduit, Aboveground: Rigid steel conduit, IMC.
 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R unless otherwise noted.
- B. Comply with the following indoor applications, unless otherwise indicated:
 1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit or IMC. Includes raceways in the following locations:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.

SECTION 16130 - RACEWAYS AND BOXES

5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: Rigid steel conduit or IMC.
7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway.
8. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway.
9. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: General-use, optical fiber/communications cable raceway.
10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 1/2-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Properly support raceways.

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

SECTION 16130 - RACEWAYS AND BOXES

- J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- K. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
 2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
 3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.
- M. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.
1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.
 3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
- N. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- O. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- P. Set metal floor boxes level and flush with finished floor surface.
- Q. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

SECTION 16130 - RACEWAYS AND BOXES

- R. Install exposed raceways parallel or at right angles to nearby surfaces or structural members.
- S. Where raceways enter boxes or cabinets that do not have threaded hubs, raceways shall be secured in place with galvanized locknuts inside and outside of the enclosure, and shall have a bushing inside. All raceway ends, including those for empty conduits, shall have bushings.
- T. Conduits leaving air handling units, fan coils, air conditioners, outside air units or any other pressurized tempered air moving equipment shall be sealed with Ductseal #203. The conduit is to be sealed inside of the junction box or as it leaves the equipment.
- U. Avoid installing boxes back to back in walls. Provide not less than 12 inches separation.
- V. Position recessed boxes accurately to allow for surface finish thickness.
- W. Secure boxes firmly and rigidly to substrates, or structural surfaces to which attached.
- X. Raceways and concrete encased duct banks under structural slabs shall be adequately supported from the slab using 3/8 inch diameter stainless steel rods properly spaced (not greater than 5 feet between rods) to support the load. Exposed sections of rods shall be coated with waterproof mastic.

3.3 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.4 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 16130

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SECTION 16140 - WIRING DEVICES

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Isolated-ground receptacles.
 - 3. Hospital-grade receptacles.
 - 4. Snap switches

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

SECTION 16140 - WIRING DEVICES

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V: Comply with NEMA WD 1, NEMA WD 6 configurations 5-15R and 5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; CRF15 and CRF20 series.
 - b. Leviton; CR15 and CR20 series.
 - c. Pass & Seymour; CR15 and CR20 series.
- B. Hospital-Grade, Duplex Convenience Receptacles, 125 V: Comply with NEMA WD 1, NEMA WD 6 configurations 5-15R and 5-20R, and UL 498 Supplement SD.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; HBL8200H and HBL8300H series.
 - b. Leviton; 8200H and 8300H series.
 - c. Pass & Seymour; 8200H and 8300H series.
- C. Isolated-Ground, Duplex Convenience Receptacles, 125 V: Comply with NEMA WD 1, NEMA WD 6 configurations 5-15R and 5-20R, and UL 498.
 - 1. Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; IG5262 and IG5362 series.
 - b. Leviton; 5262IG and 5362IG series.
 - c. Pass & Seymour; IG5262 and IG5362 series.

SECTION 16140 - WIRING DEVICES

2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.2 GFCI RECEPTACLES

- A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include power on indicator light and ground fault indicator light or reset lockout device.
- B. Duplex GFCI Convenience Receptacles, 125 V, 15 A and 20 A:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Leviton; 7599 and 7899 series.
 - b. Pass & Seymour; 1595L and 2095L series.
 - c. Hubbell; GFST15 and GFST20 series.
- C. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 15 A and 20 A: Comply with UL 498 Supplement SD.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; GFR8200HST and GFR8300HST series.
 - b. Leviton; 7599HG and 7899HG series.
 - c. Pass & Seymour; 1595HG and 2095HG series.

2.3 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - b. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - c. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
- C. Pilot Light Switches, 20 A:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221PL for 120 V and 277 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - d. Pass & Seymour; PS20AC1-PLR for 120 V.

SECTION 16140 - WIRING DEVICES

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Cooper; 2221L.
- b. Hubbell; HBL1221L.
- c. Leviton; 1221-2L.
- d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.4 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic. Use Type 302 non-magnetic brushed finish stainless steel on concrete or masonry construction.
3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, thermoplastic with lockable "WHILE IN USE" cover.

2.5 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: Ivory, unless otherwise selected by Architect, or unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. Isolated-Ground Receptacles: As specified above, with orange triangle on face.
4. Wall plate color shall match color of wiring device.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.

SECTION 16140 - WIRING DEVICES

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening. Device plates shall be installed with all four edges in contact with finished wall surfaces.

SECTION 16140 - WIRING DEVICES

- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

- A. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with white-filled lettering on face of plate, on wall behind plate and durable wire markers or tags inside outlet boxes.
- B. Communications Outlets: Identify wiring closet and termination/port number for each jack. Use hot, stamped or engraved machine printing with white-filled lettering on face of plate, on the wall behind plate and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS

- A. Properly ground all wiring devices.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
 - 2. Test Instruments: Use instruments that comply with UL 1436.
 - 3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Test straight blade convenience outlets in patient-care areas and hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

END OF SECTION 16140

SECTION 16511 - INTERIOR LIGHTING

SECTION 16511 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, and ballasts.
2. Lighting fixture supports.

B. Related Sections:

1. Division 13 Section "Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
2. Division 16 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
3. Division 16 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. LER: Luminaire efficacy rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
1. Physical description of lighting fixture including dimensions.
 2. Emergency lighting units including battery and charger.

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3. Ballast, including BF.
 4. Energy-efficiency data.
 5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
 6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
 - a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
 - b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Installation instructions.
- C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Lighting fixtures.
 2. Suspended ceiling components.
 3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches (305 mm) of the plane of the luminaires.
 4. Structural members to which suspension systems for lighting fixtures will be attached.
 5. Other items in finished ceiling including the following:
 - a. Air outlets and inlets.
 - b. Speakers.
 - c. Sprinklers.
 - d. Smoke and fire detectors.
 - e. Access panels.
 6. Perimeter moldings.
- D. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.
- E. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.
- F. Field quality-control reports.
- G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.
- H. Warranty: Sample of special warranty.

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1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least [0.125 inch (3.175 mm)] minimum unless otherwise indicated.
 - b. UV stabilized.
- G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp and ballast characteristics:

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- a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
 - d. CCT and CRI for all luminaires.
- H. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

2.2 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts:

1. Comply with UL 935 and with ANSI C82.11.
2. Designed for type and quantity of lamps served.
3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
6. Operating Frequency: 42 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.9 or higher.
9. Power Factor: 0.95 or higher.
10. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. luminaires controlled by occupancy sensors shall have programmed-start ballasts.

C. Electronic Programmed-Start Ballasts for T5 T8 T5HO Lamps: Comply with ANSI C82.11 and the following:

1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
2. Automatic lamp starting after lamp replacement.

D. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 30 percent of rated lamp lumens.
2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

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2.3 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
1. Lamp end-of-life detection and shutdown circuit.
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: Class A.
 4. Total Harmonic Distortion Rating: Less than 20 percent.
 5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 6. Operating Frequency: 20 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. BF: 0.95 or higher unless otherwise indicated.
 9. Power Factor: 0.98 or higher.
 10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.4 FLUORESCENT LAMPS

- A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours unless otherwise indicated.
- B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours unless otherwise indicated.
- C. T5 rapid-start lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 K, and average rated life of 20,000 hours unless otherwise indicated.
- D. T5HO rapid-start, high-output lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 K, and average rated life of 20,000 hours unless otherwise indicated.
- E. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at three hours operation per start[.
1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
 2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
 3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
 4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
 5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
 6. 57 W: T4, triple tube, rated 4300 initial lumens (minimum).
 7. 70 W: T4, triple tube, rated 5200 initial lumens (minimum).

2.5 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 16 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

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- B. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, [12 gage (2.68 mm)]
- C. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, [12 gage (2.68 mm)]
- D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures:
 - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
 - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.
- D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
 - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

3.2 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 16 Section "Electrical Identification."

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3.3 FIELD QUALITY CONTROL

- A. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.4 STARTUP SERVICE

- A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

END OF SECTION 16511

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