

DIVISION 16

ELECTRICAL

Sizeier Thompson Brown Architects
300 Lafayette Street, Suite 200
New Orleans, LA 70130
Phone: 504-523-6472
Fax: 504-529-1181

www.sizeierthompsonbrown.com



SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section is an extension of the General Requirements (Division 1 of these Specifications) and certain items of a common or administrative nature that pertain to all electrical work.
- B. The work of this section consists of furnishing materials, equipment, constant competent supervision, special tools, test equipment, technicians, and labor necessary for installation of a complete working electrical system as indicated herein and on the Drawings.
- C. The work shall include but not necessarily be limited to the following:
 - 1. Service entrances and mounting of metering equipment as required by the utility company
 - 2. Connections to service from points of termination by utility company
 - 3. Power Distribution Systems: feeder circuits, branch circuits, panels, wiring, transformers, devices, etc.
 - 4. Installation of motor control and variable frequency drive equipment
 - 5. Electrical work incidental to the requirements of the mechanical system.
 - 6. Wiring and connections to equipment furnished and installed under other Divisions of these specifications
 - 7. Raceways and fittings
 - 8. Grounding
 - 9. Lighting System: fixtures, lamps, wiring, connections, etc.
 - 10. Telecommunications System
 - 11. Lighting control system
 - 12. All required sleeves, thimbles, anchors, hangers, bolts, miscellaneous structural steel, cutting, etc., for the complete installation of the electrical systems serving the building
 - 13. Temporary electrical service for construction and maintenance of occupied portions of the building's electrical systems
 - 14. Standby Generator System

1.2 RELATED DOCUMENTS

- A. Drawings
- B. General provisions of Contract, including General and Supplementary Conditions.

C. Division 01 - Specification Sections

1.3 QUALITY ASSURANCE

- A. The electrical installation shall conform to the requirements of the 2005 edition of the National Electrical Code (NEC). Notify Architect of conflicts before performance.
- 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. Electrical materials shall be new and unused and shall be listed and labeled for the service intended by Underwriters' Laboratories, Inc., where such labeling service is available.
- D. Applicable sections of the following codes and standards shall also be followed:
 - 1. NFPA - National Fire Protection Association including NFPA-101, Life Safety Code.
 - 2. OSHA Code of Federal Regulations
 - 3. IBC - International Building Code as adopted by the local authority having jurisdiction.
 - 4. Applicable state and local codes and ordinances
 - 5. ETL - Electrical Testing Laboratories
 - 6. IES - Illuminating Engineering Society
 - 7. NECA - National Electrical Contractors Association
 - 8. UL - Underwriters Laboratories
- E. 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.

1.4 REGULATORY REQUIREMENTS

- 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 NFPA and all municipal, state or other authority having jurisdiction over the work.
- 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.

1.5 COORDINATION

- A. Layout the work and be responsible for its correctness. Take such measurements as may be necessary to assure approved fitting and proper installation of work, and all other work depending thereon.
- B. Arrange work in a neat, well organized manner with exposed conduit and similar services running parallel with primary lines of the building construction, high as possible with a minimum of 8'-0" overhead clearance or as directed by the Architect.
- C. Perform all work in the best and most substantial manner by workmen skilled in the work to be done. Provide adequate supervision at all times.
- D. Cooperate with other contractors to avoid complications between the installation of the various items of equipment. Advise other trades of openings required in their work for the subsequent move-in of large units of electrical equipment.
- E. Locate operating and control equipment properly to provide easy access, and arrange entire electrical work with adequate access for operation and maintenance.
- F. Where the method of installation is not certain, ask for details. Lack of details, not requested, will not be an excuse for improper installation, and any such work must be corrected.
- G. Coordination Drawings: For locations where several elements of electrical or combined mechanical and electrical 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 1/4") required for the installation. Prepare and submit coordination drawings prior to purchase-fabrication-installation of any of the elements involved in the coordination.
- H. All Bidders shall be responsible to insure that equipment selected: switchboards, panelboards, etc., fit in spaces selected, and meet all NEC 110.26 requirements. If standard equipment does not fit, Contractor shall be required to utilize custom equipment as required.

1.6 DRAWINGS AND SPECIFICATIONS

- A. Contract Documents (Drawings and Specifications) are intended to convey the scope of work and indicate general arrangements of equipment, fixtures and piping, and approximate sizes and locations of equipment and outlets. Follow these documents in laying out the work, check all Drawings to become familiar with all conditions affecting the work, and verify spaces in which the work will be installed.
- B. The contract documents are diagrammatic in showing certain but not all, physical relationships which must be established within the electrical work. Its interface with other work including plumbing, fire protection and mechanical work is the exclusive responsibility of the Contractor.
- C. The Drawings show approximate locations only of selected feeders, branch circuits, outlets, etc., except where specific routing or dimensions are indicated. The Architect reserves the right to make reasonable 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, and accessories required. Contractor shall investigate the structural and finish conditions affecting Division 16 work and shall arrange such work accordingly, furnishing fittings, bends, junction boxes, pull boxes, access panels, and accessories required to meet such conditions.
- E. These Specifications, together with the accompanying Drawings, contemplate apparatus fully erected, and in satisfactory operating condition with the Contractor furnishing and installing everything that may be necessary to complete the job.

1.7 SUBMITTALS

- A. Refer to Section 01330 for Submittal Requirements. The following paragraphs are an extension of Section 01330.
- B. Review of shop drawings shall in no way modify the contract or relieve the Contractor from compliance with the contract.
- C. Names of manufacturers or catalog numbers are listed in the Specification in order to establish a standard for the type, general design and quality of the product required. Where "or approved equal" is indicated, other products similar in design and of equal quality and complying with the Drawings and Specifications will be considered for acceptance. See Section 01630 - Product Substitutions.
- D. Any item not specified herein, but submitted as a substitute for the specified item, shall be submitted in accordance with Section 01630 - 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 and weight
2. Electrical Ratings: voltage, amperage, short circuit rating, 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. Any deviations

E. Equipment Requiring Submittals:

1. The following items and equipment require submittals for transmittal. Refer to Phasing Plan for scheduling of submittals. No time delays will be allowed for failure to be so informed.
 - a. Lighting Fixtures
 - b. Lighting Controls
 - c. Lamps
 - d. Safety Switches
 - e. Fuses
 - f. Circuit Breakers
 - g. Wiring Devices
 - h. Panelboards
 - i. Relays and Contactors
 - j. Fire Alarm System Components
 - k. Generators
 - l. Automatic Transfer Switches
 - m. Telecommunication Cabling
 - n. Telecommunication Patch Panels
 - o. In-slab conduit layout drawing with dimensions
 - p. Equipment layout in all Electrical Rooms
2. Further descriptions or information required with shop drawings shall be included with the description of materials specified herein as follows:
 - a. Fire Alarm Components: Include shop Drawings showing fire alarm system riser, wiring diagrams and dimensioned Drawings of Fire Alarm Control Panel. Include certification that this Division has fully coordinated all fire alarm system signal and control connections to work of the other Divisions, including but not limited to, automatic temperature controls, fire pump, fire sprinkler system, and elevators.
 - b. Housekeeping Pads: Include location and dimensions of housekeeping pads, including blockouts and anchor bolts.
 - c. Firestops: Include all firestop materials for the project, indicating intended use and UL fire rating where applicable.

- d. Detailed, dimensioned shop Drawings for the installation of the work in the electrical equipment rooms shall be prepared and submitted for review. These Drawings shall be new Drawings prepared by the Contractor and shall not be reproductions or tracings of the Drawings. In preparing shop Drawings, establish lines and levels for the work specified and check the Drawings to avoid interference with structural features and the work of other trades. Immediately call to the attention of the Architect in writing any interference for clarification.
 - e. Detailed, dimensioned shop drawing for the installation of the conduits to be installed in the floor slab. These shop drawings shall be new drawings prepared by the contractor and shall show all conduit rating, locations where conduits are exiting slab. All junction boxes and concrete rings shall have dimensioned locations. Coordinate conduit "turn-up" or turn downs" with architect. Drawings to insure all conduits will be concealed either in the slab or in the walls.
3. Corrections or 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 information given in the contract documents.
 4. Review of the shop Drawings shall not relieve the Contractor from responsibility for confirming 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.

1.8 PROTECTION OF APPARATUS

- A. At all times the Contractor shall take precautions necessary to protect his apparatus from damage. Failure on the part of the Contractor 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.

1.9 PROJECT/SITE CONDITIONS

- A. Visit the site before bidding to become familiar with conditions under which the work will be performed.
- B. No additional compensation will be allowed for failure to be so informed.

1.10 CUTTING AND PATCHING

- A. Do all cutting, fitting, and all other work that may be required to make the several parts come together and fit. Cutting for equipment entry shall be under

other Divisions. Do not endanger any work by cutting, digging, or otherwise, and do not cut or alter the work of any other Divisions, except with the consent of the Architect. Cutting shall be done under the supervision of the Project Superintendent. Patching, including patching of bonded roofing, shall be performed under Section 01732.

- B. 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.
- C. It is the responsibility of this Division to coordinate with other responsible Divisions for required cutting and patching.

1.11 FIREPROOFING:

- A. Where conduit and/or cables penetrate fire-resistant/rated walls, partitions, ceilings, or floors, adequate fire seals using approved UL methods to maintain the fire-resistance rating shall be provided and installed.
- B. Approved methods constitute providing a minimum of one-inch (1") depth of Scotch Putty 303 or Caulk CP25.3 surrounding metal conduit penetrations. Larger square or circular penetrations shall require construction of fire-rated barrier utilizing Scotch Series 7903/7904 barrier sheets.
- C. Plastic sleeves/pipe shall not be used within the building when penetrating a fire-resistant-rated wall, ceiling, partition, or floor.
- D. All fire proofing to be certified.

1.12 INSERTS AND THIMBLES

- A. Set in place as form work progresses, all necessary inserts and thimbles as may be required. Cutting of beams or of concrete floors or walls will not be permitted.
- B. All thimbles set in concrete shall be of standard pipe, plain ends, and shall be of proper size to allow for freedom around piping passing through thimble.
- C. Thimbles set in the walls, partitions or in chases where structural requirements will allow, shall be of rigid galvanized steel conduit.
- D. Inserts shall be nailed to form work and shall be of size to allow for installation of hangers for the particular pipe served.

1.13 RECORD DRAWINGS

- A. Prepare Record Drawings in accordance with the requirements in Division 1 Section 01770, "CLOSEOUT PROCEDURES." The following paragraphs are in addition to Section 01770.
- 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. Contract Modification, actual equipment and materials installed.
 - 4. Complete As-Built Drawings of Division 16 work shown and not shown on the contract drawings in the new and existing facilities.
- C. Equipment Manuals:
 - 1. 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:".
 - 2. Each set of this literature shall be bound in a permanent type hard cover ring binder and shall be suitably indexed.
 - 3. This submittal shall be accompanied by final Electrical Inspection Certificate from the authority having jurisdiction and Statement of Inspection from State Fire Marshal's Office.

1.14 WARRANTY/GUARANTEE

- A. Except where longer periods of warranty are specified, guarantee all labor and materials for a period of twelve (12) months from the date of substantial completion of the particular phase of the work. Repair all defective materials and work; replace with new materials and/or equipment, any material and/or equipment failing to give satisfactory service.
- B. During the period of guarantee, promptly correct any defects in equipment, materials or workmanship without cost to the Owner.
- C. Guarantee includes equipment capacity and performance ratings specified without excessive noise levels. Any deficiencies in equipment specified shall be promptly corrected.
- D. Contractor's warranty shall include an inspection of the system one (1) week before the end of the one (1) year warranty period. Replace or repair any items found to be defective at this time.

1.15 TESTS AND BALANCING

- A. At such times as the Architect directs, conduct operating tests to demonstrate that the electrical systems are installed and will operate properly and in accordance with the requirements of this Specification. Tests shall be performed in the presence of the Architect's representative. Furnish instruments and personnel required for such tests.
- B. All power and lighting loads shall be tested by Contractor prior to final approval.
- C. Any work and materials tested and found varying from the requirements of the Drawings and Specifications shall be replaced without additional cost to the Owner.
- D. This section does not relieve the Contractor from testing equipment installed under this Division but not listed in this section. Contractor is required to test all equipment, feeders, etc., installed under this Division.

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 and as referenced in Section 09910. 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.

2.2 MANUFACTURERS' NAMEPLATES

- A. Each major component of the equipment shall have the manufacturer's name, address, model number, and rating on a plate securely affixed in a conspicuous place. The nameplate of a distributing agent will not be acceptable. NEMA Code ratings, or other data which are die-stamped into the surface of the equipment shall be stamped in an easily visible location.

PART 3 - EXECUTION

3.1 GENERAL

- A. Visit the building site before bidding to determine existing conditions and assume all responsibility and bear all expenses in allowing for these conditions in the bid.
- B. No work shall be concealed until approved by the local inspector and all local regulations are adhered to.
- C. Upon completion, a certificate of approval from the appropriate regulatory agency shall be furnished to the Architect.
- D. Study all sections of the Specifications and Drawings. Notify Architect of conflict between Drawings and Specifications before bidding.
- E. Electrical Drawings are diagrammatic except where dimensioned. Do not scale. Follow manufacturers certified shop drawings for accuracy. 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

- A. Furnish and install provisions for temporary electrical service and construction light and power during the construction period conforming to the contract documents, all local code and State labor law requirements.
- B. Arrange for temporary service with the Utility Company.
- C. Furnish, install, and maintain all temporary service equipment as required until permanent service is installed switch-over of temporary systems on the permanent service when latter is ready for same.
- D. Furnish, install, maintain, and switch on and off on all regular work days a complete temporary light system, for the building while under construction.
- E. Provide any and/or all relocations of temporary electric facilities as necessary to clear the permanent installations of all trades.

3.3 WIRING FOR EQUIPMENT BY OTHERS

- A. Electrical service for all equipment furnished under this Specification and/or indicated on the Drawings shall be roughed-in and connected under this Section. It is the responsibility of the Contractor to obtain correct roughing-in dimensions and requirements for this equipment.

- B. Raceways, outlets, backboards, cabinets, grounding connections, handholes, underground distribution system, and other roughing-in indicated shall be provided as work of this division for telephone system, security system and data system.

3.4 MECHANICAL EQUIPMENT

- A. All power wiring associated with Division 15, Mechanical shall be done as work of Division 16, Electrical. All power disconnect switches and single speed manual starting switches shall be furnished and installed under Division 16. Multi-speed manual starters, magnetic starters, variable frequency drives shall be furnished under Division 15 and installed under Division 16.
- B. Except as may be indicated on the Drawings and/or hereinafter noted, all control wiring, including all temperature control wiring, interlocking, start-stop wiring, shall be furnished and installed under Division 15. This includes, but is not limited to, wiring to low voltage thermostats, damper motors, aquastats, firestats, pushbuttons, selector switches, and control panel(s). All disconnect switches for control shall be furnished and installed under Division 15. Wiring, conduit, and control shall meet the requirements of Division 16
- C. Work of other divisions will include furnishing and setting motors.
- D. All magnetic starters and variable frequency drives will be furnished under Division 15, except for packaged equipment that will be furnished under another division of the Specifications. Overload elements in all 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 was furnished.
- E. Firestats for single phase exhaust fans with manual starting switches and wall mounted thermostats which interrupt line voltage power circuits to motors shall be furnished and set under Division 15, and electrically connected in the branch circuit wiring as work of Division 16.

3.5 WORKMANSHIP

- A. 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.

- B. As practicable, the lines of all components of the system shall be perpendicular or parallel. In general, workmanship shall conform to guidelines set forth in N.E.C.A. manuals.

3.6 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.

3.7 SAFETY

- A. 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

SECTION 16051

ELECTRICAL RELATED WORK

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Extent of electrical related work required by this section is indicated on Drawings and/or specified in other Division 16 sections.
- B. Types of electrical related work specified in this section include the following:
 - 1. Access to Electrical Work:
 - a. Removable cover plate in walls, ceiling and floors
 - 2. Excavating, Trenching and Backfill for Electrical Work
 - 3. Foundations and Supports
 - 4. Cutting and patching
 - 5. Concrete for Electrical Work:
 - a. Encasement of electrical work
 - b. Underground structural concrete to accommodate electrical work
 - c. Electrical equipment foundations and mounting pads
 - d. Rough grouting in and around electrical work
 - e. Patching concrete which has been cut to accommodate electrical work

1.2 RELATED DOCUMENTS

- A. Drawings
- B. General provisions of Contract, including General and Supplementary Conditions.
- C. Division 01 - Specification Sections.
- D. Section 16010 - Basic Electrical

1.3 PROJECT/SITE CONDITIONS

- A. Protect property from damage which might result from excavating and backfilling.
- B. Protect persons from injury at excavations by barricades, warnings and illumination.
- C. Coordinate excavations with weather conditions, to minimize possibility of washouts, settlements and other damages and hazards.

1.4 ACCESS TO ELECTRICAL WORK

- A. Access Doors: General: Where floors, walls and ceilings must be penetrated for access to electrical work, provide types of access doors indicated by project conditions, including floor doors if any. Furnish sizes indicated or, where not otherwise indicated by project conditions, furnish adequate size for intended and necessary access. Furnish manufacturer's complete units, of type recommended for application in indicated substrate construction, in each case, completes with anchorages and hardware.
- B. Access Door Construction: Except as otherwise indicated, fabricate wall/ceiling door units of welded steel construction with welds ground smooth; 16-gage frames and 14-gage flush panel doors, 175 degree swing with concealed spring hinges; flush screw-driver-operated cam locks; factory-applied rust-inhibitive prime-coat paint finish.
- C. Removable Access Plates: General: Where switches, control devices, pull boxes, and similar elements of electrical work are located within or behind wall or ceiling construction of finishes, or below grade, and are not (cannot be) provided with integral removable access plates as specified in other Division-16 sections, provide removable access plates of types and sizes needed for access requirements. Provide manufacturer's complete units with anchorages, fasteners, and standard factory-applied finishes.
- D. Wall/Ceiling Unit Construction: Except as otherwise indicated, and where adaptable to substrate, provide manufacturer's standard frameless round formed stainless steel or chrome-plated brass low-profile plate cover, with single exposed flush screw anchor, with bright polished finish.
- E. Units Set at Grade: Except as otherwise indicated, provide manufacturer's standard round or square cast-iron units, complete with cast-iron pipe extension to protect electrical elements being accessed; designed to be set slightly above finish grade, and to be encased in concrete; secure plate to body with bronze screws; natural mill finish on plate and body.

1.5 EXCAVATING FOR ELECTRICAL WORK

- A. Backfill Materials: Refer to Division 2 Section, Earthwork.
- B. Materials of Concrete Work: Refer to Division 3 Section, Concrete.

1.6 DUCT BANK COLORING

- A. All underground and above grade concrete electrical duct banks shall be colored red.

PART 2 - EXECUTION

2.1 EXCAVATION, TRENCHING AND BACKFILLING

- A. Perform all excavation of every description and of whatever substances encountered to the depths indicated on the Drawings or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or not suitable for backfill shall be removed and wasted or removed from jobsite as indicated on the Drawings or as directed by Architect at no additional cost to Owner.
- B. Sheet piling and shoring shall be done as necessary for the protection of the work and for the safety of personnel. Provide necessary pumping and/or well pointing at all times to maintain a dry working condition in all trenches. Unless otherwise indicated, excavations shall be by open cut except that short sections of a trench may be tunneled if, in the opinion of the Architect the conduit can be safely and properly installed and backfill can be properly tamped in such tunneled sections.
- C. No excavation or trenches shall be cut near or under footings without first consulting Architect.
- D. Where open cut excavations/trenches are near tree root system, consult architect for directions prior to excavation. Contractor shall ultimately be responsible for installations of conduits by methods best suited to preserve tree root systems as per architect directions.
- E. Bottom of trench shall be shaped to give substantially uniform circumferential support to lower third of each pipe. Each pipe shall be laid true to line and grade and in such manner as to form a close concentric joint with adjoining pipe and to prevent sudden offset to flow line. As work progresses, interior of pipe shall be cleared of dirt and superfluous materials of every description.
- F. Wherever wet or otherwise unstable soil that is incapable of properly supporting the pipe, as determined by the Architect is encountered in the bottom of the trench, such soil shall be removed to the depth required and the trench backfilled to the proper grade with coarse sand, fine gravel, or other suitable material, and approved by the Architect.
- G. Trenches for utilities shall be of a depth that will provide the following minimum depth of cover from existing grade or from indicated finish grade, whichever is lower, unless otherwise specifically shown:

- 1. 30-Inch Minimum Cover - Electrical Conduits/Cables over 600 volts

2. 24-inch Maximum (See NEC 300-5) - Electrical Cables/Conduits Under 600 volts.
- H. Backfill shall be installed in layers 6" deep, adequately wetted and tamped using materials as noted above. The surface shall be graded to a reasonable uniformity and the mounding over trenches left in a uniform and neat condition as approved by the Architect. Refer to plans for compaction densities.
- I. Restore all hard finished surfaces such as roadways, sidewalks, grass, shrubbery, etc., removed for installation of utilities (and not shown on Drawings or specified to be reworked under other sections of the work) to their original condition using the same type as original materials. Patching concrete roadways shall require doweling to tie-in matching reinforcement rods or highway mesh to existing roadway. Doweling shall occur every 18 inches on both sides of the trench. Restore to near original condition acceptable to Architect.
- J. Carefully plan all work to avoid existing utilities and other interferences. The Drawings do not indicate all existing underground utilities. Existing utility lines to be retained that are shown on the Drawings or the locations of which are made known to the Contractor prior to excavation, as well as all utility lines uncovered during excavation operations, shall be protected from damage during excavation and backfilling and, if damaged, shall be repaired by Contractor at his expense. Prior to doing any excavation with power tools, carefully investigate and locate any exiting conduit, pipes, and other lines.
- K. Install access units in accordance with manufacturer's written instructions, in compliance with NEC and recognized industry practices.
- L. Coordinate with other work, including substrate construction work, as necessary to interface installation of access units with other work.
- M. Locate each removable access unit accurately in relation to electrical work requiring access.
- N. Provide adequate temporary support or attachment to framing or form work so that units will not be dislocated during construction of substrates.
- O. Set frames accurately in position and securely attach to supports with face panels plumb or level in relation to adjacent finish surfaces.
- P. Adjust hardware and panels after installation for proper operation.
- Q. Remove and replace panels or frames, which are warped, bowed or damaged.

2.2 PAINTING

- A. Factory painted equipment shall have finish restored to Manufacturer's finish if scratched or damaged before acceptance or use by Owner.

END OF SECTION

SECTION 16060

GROUNDING & BONDING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. The work of this section consists of providing labor, materials, tools, appliances and miscellaneous accessories associated with grounding of the electrical system as required by and as is indicated herein and/or on the Drawings.
- B. Main electric service equipment, raceways, motors, panelboards and other electrical equipment shall be effectively and permanently grounded to a grounding electrode. This electrode shall be the nearest available effectively grounded structural metal member of the structure or the nearest available effectively grounded metal water pipe and also a driven rod. Grounding connections and conductor sizes shall be in accordance with requirements of the National Electrical Code, Article 250, and local ordinances, and as described herein.
- C. A separate grounding conductor, sized in accordance with NEC Table 250.122 shall be provided in the conduit with the circuit conductors for all feeder and branch circuits. The grounding conductor may be bare or insulated copper; however, if this conductor is insulated, the insulating covering shall be a green color. Conduit runs shall be increased in size where necessary to accommodate the grounding conductor in addition to circuit conductors. The electrical continuity of all conduit runs shall be verified and corrected where necessary.
- D. Isolated Ground Connectors shall be insulated. Additional grounding conductors and conduit shall be provided as specified herein or shown on the drawings. All conduit for grounding system conductors, not run in conduit with circuit conductors, shall be rigid steel conduit.
- E. All electrical equipment enclosures and conductor enclosures shall be grounded. This includes but is not limited to metal raceways, outlet boxes, cabinets, switch boxes, motor frames, transformer cases and metallic enclosure for all electrical equipment.
- F. Under no circumstances shall neutral conductors again be grounded after they have been grounded once at the transformer secondary.
- G. Panelboards shall be equipped with a neutral bar which is insulated from the enclosure, and a grounding bar which is bonded to the enclosure. The grounding bar shall provide for terminating the green equipment grounding conductors in the panelboard or motor control center cabinets. The grounding bar shall be

bonded to the cabinet. Neutral busses shall be isolated from ground except at the transformer ground connection.

H. Types of grounding in this section includes the following:

1. Underground metal water piping
2. Grounding electrodes
3. Service equipment
4. Enclosures
5. Systems
6. Equipment

I. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

J. Provide Bonding Jumper across water meter.

1.2 RELATED DOCUMENTS

- A. Drawings
- B. General provisions of Contract, including General and Supplementary Conditions.
- C. Division 01 - Specification Section.
- D. Section 16010 - Basic Electrical Requirements.

PART 2 - PRODUCTS

2.1 GROUNDING

A. Materials and Components:

1. General: Except as otherwise indicated, provide electrical grounding and bonding systems indicated, with assembly of materials including, but not necessarily limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes, bonding jumper braid, surge arrestors and other items and accessories needed for complete installation. Where more than one type meets indicated requirements, selection is Installer's option. Where materials or components are not otherwise indicated, comply with NEC, UL and IEEE requirements and with established industry standards for applications indicated.
2. Bonding Jumper Braid: Copper braided tape, constructed of 30-gage bare copper wires and properly sized for indicated applications.

3. Flexible Jumper Strap: Flexible flat conductor, 480 strands of 30-gage bare copper wire, 3/4" wide, 9-1/2" long, 48, 250 CM. Protect braid with copper bolt hole ends with holes sized for 3/8" dia. bolts.
4. Grounding Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC.
5. Connectors, Terminals and Clamps: Provide electrical bonding plates, connectors terminals and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for indicated applications.
6. Ground Electrodes: Ground Rods: Steel with copper welded exterior, 5/8" dia. X 10'.
7. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, solder, soldering flux, bonding straps, as recommended by accessories manufacturers for type services indicated.
8. Field Welding: Comply with AWS code for procedures, appearance, and quality of welds and methods used in connecting welding work. Provide welded connections where grounding conductors connect to underground grounding rods/electrodes.

PART 3 - EXECUTION

3.1 INSTALLATION OF GROUNDING SYSTEMS

- A. Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure grounding and ground-fault protection devices comply with requirements. Comply with requirements of NEC, and NECA's "Standard of Installation".
- B. Coordinate with other electrical work as necessary to interface installation of grounding system and ground fault protection devices with other work.
- C. Cadweld grounding conductors to underground grounding electrodes. The building equipment grounding system shall consist of the ground wire, and electrically continuous metallic conduit system. Every item of equipment served by the electrical system shall be bonded to the building equipment ground.

Portions of metallic piping and duct systems which are electrically isolated shall be bonded to the equipment grounding system with a flexible bonding jumper.

- D. The neutral shall be grounded to the grounding electrode system at the service entrance only, and shall be kept isolated from the building grounding system

- throughout the building. The neutral of separately derived systems shall be grounded at one point.
- E. Provide bonding and grounding wires run in conduit and sized per the NEC in accordance with the local electrical inspection department and the NEC. Metallic piping and duct systems which enter the building shall be grounded at the point of entry to the building, in accordance with the NEC.
 - F. 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 conduit, light fixture pigtails in excess of 6', and all other nonelectrically continuous raceway fittings.
 - G. All main grounding conductors shall be stranded copper conductors, sized as shown and/or required, and run in a suitable raceway. All main grounding conductors shall be continuous without joints or splices over their entire length.
 - H. Bond the case and neutral of each transformer directly to the nearest available effectively grounded structural metal member of the structure, the nearest available effectively grounded metal water pipe, or in accordance with the local electrical inspection department. Flexible conduit shall not be used as a ground path to a transformer.
 - I. Provide a #6 ground conductor from the telephone service equipment to the building grounding system as required by the local Telephone Company.
 - J. Carefully and securely ground all fluorescent fixture bodies to the conduit grounding system. Flexible conduit longer than 6' shall not be considered a ground path.
 - K. Ground all grounding-type receptacles with a separate ground wire.
 - L. 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 and rigid conduit system. Grounding conductor shall be sized in accordance with NEC Table 250.122.
 - M. 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.

- N. Grounding conductors shall be not smaller than #12 AWG. Conductors shall be high conductivity copper, and sizes larger than #10 shall be stranded.
- O. Insulated bushings shall be installed on all raceways at transformers, switchboards, motor-control centers, dry-type transformers, as well as switches used as service equipment.
- P. Install braided type bonding jumpers with clamps on water meter piping to electrically bypass water meter.
- Q. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.
- R. For all motor circuit and all circuits serving multi-outlet assemblies provide a separate grounding conductor in addition to any conduit ground. Conduit runs shall be increased in size where necessary to accommodate the grounding conductor in addition to circuit conductors.

3.2 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding system, test ground resistance with ground resistance tester. Where tests show resistance-to-ground is over 3 ohms, take appropriate action to reduce resistance to 3 ohms or less by driving additional ground rods and/or by chemically treating soil encircling ground rods with sodium chloride, calcium chloride, copper sulphate, or magnesium. Then retest to demonstrate compliance.

END OF SECTION

SECTION 16073

HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
- B. Related Sections: The following Sections contains requirements that relate to this Section:
 - 1. Division 03 - Cast-in-place Concrete for inserts, anchors, and sleeves to be installed in concrete for use with supporting devices.
 - 2. Division 05 - Metals for requirements for miscellaneous metal items involved in supports and fastenings.
 - 3. Division 07 - Joint Sealants for requirements for fire stopping at sleeves through walls and floors that are fire barriers.
 - 4. Section 16010 - Basic Electrical

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified.
 - 1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and applications for each required type of support, hanger, sleeve, seal, and fastener to be used.
- C. Shop drawings indicating details of fabricated products and materials.

1.3 QUALITY ASSURANCE

- A. Electrical Component Standard: Component and installation shall comply with NFPA 70 "National Electrical Code."
- B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third party certification follow-up services.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps
- B. Fasteners: Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: All steel springhead type.
 - 3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- E. U-Channel Systems: 16-gage steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.2 FABRICATION

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide pipe sleeves of one of the following:
 - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:
 - a. 3-inch and smaller: 20-gage.
 - b. 4-inch to 6-inch: 16-gage.
 - c. over 6-inch: 14-gage.
 - 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
 - 3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

2.3 FINISHES

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install supporting devices to fasten electric components securely and permanently in accordance with NEC requirements, and with support manufacturer instructions.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with the NEC and the following requirements:
 - 1. Conform to manufacturer's recommendations for selection and installation of supports.
 - 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs, provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
 - 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - 4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 - 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
 - 6. Space supports for raceway in accordance with NEC.
 - 7. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
 - 8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
- D. Vertical Conductor Supports: Install simultaneously with installation of conductors.

- E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
- G. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations. For sleeves through fire-rated wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with requirements of Division 7 Section "Joint Sealants."
- H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
 - 1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
 - 2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 - 3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.
- J. TESTS: Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:
 - 1. Expansion anchors.
 - 2. Toggle bolts.
 - 3. Powder-driven threaded studs.
 - 4. E-Z type anchors.

- K. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the Architects's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. The work of this section consists of providing labor, materials, tools, appliances and miscellaneous accessories associated with electrical identification as indicated herein and on the Drawings.
- B. Types of electrical identification specified in this section include the following:
 - 1. Exposed conduit color banding.
 - 2. Cable/Conductor identification.
 - 3. Operational instructions and warnings.
 - 4. Danger signs.
 - 5. Equipment/system identification signs.

1.2 RELATED DOCUMENTS

- A. Drawings.
- B. General provisions of Contract, including General and Supplementary Conditions.
- C. Division 01 - Specification Sections.
- D. Section 16010 - Basic Electrical Requirements.

PART 2 - PRODUCTS

2.1 ELECTRICAL IDENTIFICATION MATERIALS

- A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than one type is specified for an application, selection is Installer's option, but provide single selection for each application.
- B. Cable/Conductor Identification Bands: General: Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor wire markers or wrap-around type, either pre-numbered plastic coated type, or write on type with clear plastic self-adhesive cover flap, numbered to show circuit identification.
- C. Self-adhesive Plastic Signs: Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or

warnings, of sizes suitable for application areas and adequate for visibility, with proper wording for each application (as examples: "208V", "EXHAUST FAN", "RECTIFIER"). Unless otherwise indicated or required by governing regulations, provide orange signs with black lettering.

- D. Danger Signs: Provide Manufacturer's standard "DANGER" signs of baked enamel finish on 20-gage steel, of standard red, black and white graphics, 14" x 10" size except where 10" x 7" is the largest size which can be applied where needed and except where larger size is needed for adequate vision, and with recognized standard explanation wording (as examples: "HIGH VOLTAGE", "KEEP AWAY", "BURIED CABLE", "DO NOT TOUCH SWITCH").
- E. Engraved Plastic-Laminate Signs: Provide engraved stock melamine plastic-laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, black and white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - 1. Thickness: 1/16", for units up to 20 sq. in. or 8" length, 1/8" for larger units.
 - 2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

2.2 LETTERING AND GRAPHICS

- A. Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified for scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of electrical system and equipment.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. General Installation Requirements:
 - 1. Coordination: Where identification to be applied to surfaces which require finish, install identification after completion of painting.
 - 2. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.
- B. Conduit Identification:
 - 1. General: Where electrical conduit is exposed in spaces with exposed mechanical piping which is identified by a color-coded method, apply color-coded identification on electrical conduit in a manner similar to piping

identification. Except as otherwise indicated, use orange as coded color for conduit.

C. Cable/Conductor Identification:

1. Apply cable/conductor identification on each box/enclosure/cabinet where wires are present, Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project electrical work.
2. Conductors shall be clearly and permanently identified.
3. All control circuit and instrument circuit terminations shall be identified. For conductors #6 and smaller, conductor color coding shall be color insulation. For conductor color coding of wire larger than #6, use self-adhesive wrap around tape markers. Use markers at all panelboards, boxes, outlets, switches, circuit breakers and control centers.
 - a. All ground conductors and these only: Green.
 - b. 208Y/120V: Phase Conductors: Black, red, blue. Neutral Conductor: White.
 - c. 480y/277V: Phase conductors: Yellow, Orange, Brown Neutral, Conductor: Gray.
4. Operational Instructions and Warnings: Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.
5. Equipment/System Identification:
 - a. Install engraved plastic-laminate sign on each major unit of electrical equipment in building unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, 1/2" high lettering on 1-1/2" high sign (2" high where 2 lines are required), white lettering in black field.
 - b. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for the following categories of electrical work:
 - 1) Panelboards, electrical cabinets and enclosures
 - 2) Access panel/doors to electrical facilities
 - 3) Major electrical switchboard
 - 4) Disconnect Switches
 - 5) Transformers
 - 6) Telephone switching equipment
 - 7) Fire alarm master station

- c. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate the substrate.

END OF SECTION

SECTION 16120

CONDUCTORS AND CABLES

PART 1-GENERAL

1.1 SUMMARY

- A. This Section includes wires, cables, and connectors for power, lighting, signal, control and related systems rated 600 volts and less.
- B. Related Sections: The following Sections contain requirements that relate to this section:
 - 1. Section 13852 - Fire Alarm System
 - 2. Section 16060 - Grounding & Bonding
 - 3. Section 16073 - Hangars & Supports
 - 4. Section 16130 - Raceways & Boxes

1.2 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with provisions of the following code: 2005 Ed. NFPA 70 "National Electrical Code."
 - 1. Conform to applicable Codes and regulations regarding toxicity of combustion products of insulating materials.
- B. UL Compliance: Provide components which are listed and labeled by UL under the following standards.
 - 1. UL 4
 - 2. UL 83
 - 3. UL 486
- C. NEMA/ICEA Compliance: Provide components which comply with the following standards:
 - 1. WC-5 Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy IEEE Compliance: Provide components which comply with the following standard.
 - 2. Std. 82 Test procedures for Impulse Voltage Tests on Insulated Conductors.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wire and cable according to NEMA WC-26

1.5 SEQUENCING AND SCHEDULING

- A. Coordination: Coordinate layout and installation of cable with other installations. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Architect.

PART 2- PRODUCTS

2.1 MATERIALS

- A. General: Provide wire and cable suitable for the temperature, conditions and location where indicated.
- B. Conductors: Provide stranded conductors for power and lighting circuits no. 12 AWG minimum size. Provide stranded conductors for size no. 14 AWG for control circuits.
- C. Multi-conductor Cable: Comply with NEMA WC 70 for Metal-Clad, Type MC, with ground wire. Interlocking Aluminum Strip Armor with polypropylene tape assembly covering. Meets UL 83, 1479 1569, and 1581.
- D. Conductor Material: copper for all wires and cables.
- E. Aluminum conductors shall not be used.
- F. Insulation: Provide 600 volt THHN/THWN insulation for all conductors.
- G. Color Coding for phase identification in accordance with Table 1 in Part 3 below.
- H. Jackets: Factory-applied nylon or PVC external jacketed wires and cables for pulls in raceways over 100-feet in length, for pulls in raceways with more than three equivalent 90 deg. bends, for pulls in conduits underground or under slabs on grade, and where indicated.
- I. Cables: Provide the following type(s) of cables in NEC approved locations and applications where indicated. Provide cable UL listed for particular application:
 - 1. Armored Cable.
 - 2. Factory manufactured and listed fixture whips.

2.3 ACCESSORIES

- A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.
- B. For conductors larger than number 6 AWG use compression type connectors only for splices and terminations to equipment where possible.
 - 1. At cable size transition splices use compression connectors, with bolted connection if necessary.
 - 2. Use bolted compression or tee connections where the number of connections exceed two.
- C. Split bolts and mechanical connectors may only be used if a compression method is not feasible.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all power wire in raceway as indicated in Section 16130.
- B. MC Cable may be installed in the following conditions:
 - 1. Connections to light fixtures in lay-in ceilings. Minimum inside diameter shall be 1/2".
 - 2. For all recessed and semi-recessed lighting fixtures in lay in ceilings, the cable shall be long enough to allow fixtures to be moved one ceiling grid space in any direction.
 - 3. Connections between receptacles on the same circuit run in metal stud walls.
- B. General: Install electrical cables, wires, and connectors in compliance with NEC.
- C. Coordinate cable installation with other Work.
- D. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.
- E. Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.
- F. Conceal all cable in finished spaces.
- G. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours, where possible.
- H. Keep conductor splices to minimum.
- I. TAPS and splices of No. 6 AWG and larger shall use compression bolted connectors. Splices in No 8 AWG and smaller shall be made using preinsulated wing-nut spring tension connectors manufactured by 3-M Scotch, Ideal, or approved equal.
- J. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced.
- K. Use splice and tap connectors which are compatible with conductor material.
- L. Provide adequate length of conductors within electrical enclosures and train the conductors m terminal points with no excess. Bundle multiple conductors, with conductors larger than no. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.
- M. Wiring at Outlets: Install with at least 9 inches of slack conductor at each outlet.

- N. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque's specified in UL 486A and UL 486B.
- O. Minimum size power and lighting wiring shall be No. 12 AWG.
- P. Motor control circuits may be No. 14 AWG.
- Q. Use #10 AWG Conductor for 20 AMP. 120 volt branch circuit home runs longer than 100 ft., and for a 277 volt branch circuit home runs longer than 200 ft.
- R. Conductor derating: Derate conductor ampacity in accordance with NEC raceway fill requirements. Do not fill raceways so that conductor derating will exceed 50 percent. Harmonic loading shall be considered for circuits serving office and/or classroom spaces.
- S. Power Branch circuit neutrals: Provide separate grounded conductor (neutral) for each receptacle circuit 15 and/or 20 amps, that serves office and/or classroom spaces. Harmonic's shall be assumed in these areas.
- T. Power branch circuits for receptacles in mechanical spaces, rooftop, outside convenience outlets, and other similar locations may use shared grounded conductors.
- U. Identify phases on at all termination and splice points, by a following method and as required by the NEC:
 - 1. For conductors number 6 AWG and larger use color tape, at least 4 inches at each required location.
 - 2. For conductors smaller than number 6 AWG, marking shall be completed with continuous insulation color. These conductors shall not be color taped.

3.2 APPLICATIONS

- A. Service Entrance: Type THWN, copper conductor, in raceway.
- B. Feeder and Branch Circuits: Type THHN/THWN, copper conductor, in raceway.
- C. Fire Alarm Circuits: Power-limited fire protective signaling circuit cable in conduit.
- D. Class 1 Control Circuits: Type THHN/THWN, Copper conductor in raceway.
- E. Class 2 Control Circuits: Type THHN/THWN, Copper conductor in raceway.

3.3. FIELD QUALITY CONTROL

- A. Prior to energizing, check installed wires and cables with mega-ohm meter to determine insulation resistance levels to assure requirements are fulfilled.

- B. Prior to energizing, test wires and cables for electrical continuity and for short-circuits.
- C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.
- D. TABLE 1: Color Coding for Phase Identification:
 - 1. Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows:

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

END OF SECTION

SECTION 16130

RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways and various types of electrical boxes, tubs, and enclosures for electrical wiring.
- B. Raceways include the following:
 - 1. Rigid Steel Conduit
 - 2. Intermediate Metal Conduit
 - 3. Electrical Metallic Tubing
 - 4. Rigid Nonmetallic Conduit
 - 5. Flexible Steel Conduit
 - 6. Liquid-Tight Flexible Steel Conduit
 - 7. Aluminum Conduit
 - 8. High-Density Polyethylene Conduit
- C. Boxes include the following:
 - 1. Distribution panels
 - 2. Floor boxes
 - 3. Pull and Junction Boxes
 - 4. Panelboard tubs

1.2 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for surface raceways.

1.3 QUALITY ASSURANCE

- A. Comply with NEC for components and installation. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled" as defined by the NEC, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined by OSHA Regulation 1910.7.
- B. Comply with NECA "Standard of Installation."
- C. Coordinate layout and installation of raceway with other construction elements to ensure adequate headroom, working clearance, and access.
- D. Comply with UL 50, UL 514, and UL 886. Provide electrical boxes and fittings which are UL listed for that use.

1.4 COORDINATION

- A. Installation of electrical boxes, tubs and enclosures shall be coordinated with other trades.
- B. Additional expense incurred by the contractor as a result of ill timed work will be born by the Contractor, at no additional charge to the Owner.

PART 2 - PRODUCTS

2.1 CONDUITS

A. TYPES

1. Rigid Steel Conduit (RSC): Rigid steel conduit shall be heavy wall, hot-dipped galvanized or electro-galvanized. Conduit shall be in standard 10 foot lengths, threaded on both ends. Each length shall bear an UL label showing the manufacturer's name and/or trade mark. The label shall also designate the primary protective coating. The conduit shall have the inside and outside surfaces of each length thoroughly protected against corrosion by an even coating of zinc. Zinc coating of the finished shall have an even, smooth appearance and be of uniform quality for the entire length. The zinc coating shall be protected by a coating of acid and alkali-resisting lacquer on the inside and outside of each length. Rigid steel conduit shall comply with ANSI C80.1 and UL 6.
2. Intermediate Metal Conduit (IMC): Except for the wall thickness, the intermediate metal conduit shall comply with the requirements of Rigid Steel Conduit. Intermediate metal conduit shall comply with ANSI 80.6 and UL 1242.
3. Electrical Metallic Tubing (EMT): Electrical metallic tubing shall be zinc coated steel tubing. The inside surface shall be coated with zinc or enamel. The coating on the inside and outside shall have an even and smooth appearance and be of uniform quality for the entire length. The tubing shall be in standard 10 foot lengths. Each length shall bear an UL label showing the manufacturer's name and/or trade mark. The label shall also designate the primary protective coating. Electrical metallic tubing shall comply with ANSI C80.3 and UL 797.
4. Rigid Nonmetallic Conduit: Rigid nonmetallic conduit shall be schedule 40 or 80 polyvinyl chloride (PVC) rated for use with 90 degree C conductors and sunlight resistant. The conduit shall be in standard 10 foot lengths. Each length shall bear an UL label showing the manufacturer's name and/or trade mark. Rigid nonmetallic conduit shall comply with UL 651.
5. Flexible Steel Conduit: Flexible steel conduit shall be continuous length of spirally wound, interlocked zinc-coated strip steel. Minimum size shall 1/2 inch everywhere. Flexible steel conduit shall comply with UL 1. Install separate ground conductor across flexible connections.
6. Liquid-tight Flexible Steel Conduit: Liquid-tight flexible steel conduit shall be continuous length of spirally wound, interlocked zinc-coated strip steel coated with flexible polyvinyl chloride. Minimum size shall be 1/2 inch. Liquid-tight flexible steel conduit shall comply with UL 360. Install separate ground conductor across flexible connections.

7. Aluminum Conduit: Shall be rigid and in standard 10 foot lengths, threaded on both ends. Each shall bear an UL label showing the manufacturer's name and/or trade mark.
8. MC Cable: See Section 16120 for requirements.
9. High-Density Polyethylene (HDPE) Conduit: Schedule 80 only, Meet requirements of NEMA Pub. No. TC 7-2000 for EPEC-80-HDPE and UL 651B and be UL listed for intended use

2.2 BOXES

A. DEVICE BOXES AND ACCESSORIES

1. Provide galvanized coated flat-rolled sheet-steel non-gangable device boxes, (2 1/8" deep minimum) of shapes, cubic inch capacities, and sizes, suitable for installation at respective locations.
2. Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices.
3. Provide cable clamps and corrosion-resistant screws for fastening cable clamps, and for equipment type grounding.
4. Provide device box accessories as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster board expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations.
5. Use appropriate box brackets and support to minimize box movement into wall.
6. Use wet location while in use covers for receptacles, where appropriate.

B. FLOOR BOXES

1. Provide Wiremold Resource RFB4 Recessed Floor Box or equivalent
2. STANDARDS
 - a. Comply with UL 514A
 - b. Comply with NEC 300.21
3. CONSTRUCTION
 - a. Shall be stamped steel and approved for use on above grade floors.
 - b. Box shall be 13" long by 10" wide by 3 7/16" high.
 - c. Shall be 4 independent wiring compartments that allow capacity for up to four duplex receptacles and/or communication services.
 - d. Shall be fully adjustable, providing a maximum of 2" pre-pour adjustment and a maximum of 1" after-pour adjustment.
 - e. Provide device mounting plates that accept devices shown on plan.
 - f. Provide wiring devices and telecommunication outlets as shown on drawings. See Divisions 16140 and 16716 for wiring devices.
 - g. Provide flangeless, die-cast aluminum activation covers with a black powder-coated paint finish.
4. INSTALLATION
 - a. The minimum concrete pour depth shall be 3 7/16" plus 1/16" above the top of the box.

- b. The box shall contain four locations to accommodate leveling for pre-concrete pour adjustment and shall provide four leveling screws for the pre-pour adjustment
- C. RAIN TIGHT OUTLET BOXES
1. Provide corrosion-resistant cast-metal raintight outlet wiring boxes with threaded conduit holes for fastening electrical conduit, cast-metal face plates with spring-hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners.
- D. PANELBOARD TUBS
1. Tubs shall be provided by the panelboard manufacturer.
- E. JUNCTION AND PULL BOXES
1. Provide galvanized code-gage sheet steel junction and pull boxes, with screw-on covers, welded seams and equipped with plated steel nuts, screws, and washers.
 2. Provide junction and pull boxes where required to facilitate pulling of wire whether specified or not on drawings.
 3. Maximum of 359 degrees of total turning radius shall be allowed between two pull points.
- F. BUSHINGS, KNOCKOUT CLOSURES AND LOCKOUTS
1. Provide corrosion-resistant box knockout closures, conduit locknuts, and malleable iron conduit bushings, offset connectors, to suit respective installation requirements and applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 USES

- A. Rigid Steel or Intermediate Metal Conduit:
1. Install rigid steel conduit or intermediate metal conduit for the following conditions:
 - a. Outdoor installations exposed or on rooftop
 - b. Indoor conduit over 4" diameter
 - c. Conduit subject to water or physical damage, unless otherwise specified
 - d. Installations in hazardous-classified areas
- B. Electrical Metallic Tubing (EMT):
1. Install electrical metallic tubing for wiring less than 600 volts and in dry locations for the following conditions:

- a. Indoor branch circuits
 - b. EMT may be installed exposed above suspended ceilings in office areas or in partitions in office areas
 - c. EMT shall not be used in concrete, direct burial, or in water softener areas or similar corrosive locations.
 - d. Panelboard and mechanical equipment feeders
- C. Rigid Nonmetallic Conduit:
1. Install rigid nonmetallic conduit (PVC) for the following conditions:
 - a. Underground branch circuits and feeders.
 - b. Underground signal, control, and communication circuits.
 - c. Conduit installed in slab or other flat concrete.
- D. Liquid-Tight Flexible Steel Conduit:
1. Install liquid-tight flexible steel conduit for the following conditions:
 - a. Connections to equipment subject to vibration, movement, or noise transmission such as motors, transformers, generators, dimmer banks.
 - b. Exterior equipment connections
 2. Maximum length is 6 feet.
- E. Aluminum Conduit
1. Conduit subject to chemical reactions causing corrosion.
- G. MC Cable: See Section 16120 for uses.
- H. High-Density Polyethylene (HDPE) Conduit
1. Install HDPE conduit for the following conditions
 - a. All conduit requiring boring for installation
 - b. Conduits between telecommunication hand holes and telecommunication man holes

3.3 INSTALLATION

- A. Install all electrical raceways and factory assemblies in accordance with manufacturer's written installation instructions, applicable requirements of NEC.
- B. Complete installation of electrical raceways before starting installation of conductors within raceways.
- C. Use approved conduit hangers and support conduit in a neat and orderly manner regardless of location.
- D. Die cast conduit couplings and connectors are prohibited.
- E. Conceal conduit within finished walls, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues or hot water pipes. Install raceways level and square and at proper elevations.

- F. Where possible, install horizontal raceway runs above water piping.
- G. Prevent foreign matter from entering raceways by using temporary closure protection.
- H. Make bends and offsets so the inside diameter is not effectively reduced. Keep the legs of a bend in the same plane and the straight legs of offsets parallel.
- I. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions.
- J. When conduit extends below the bottom of a slab on the ground, the slab shall be thickened in the area of the conduit so as to encase the conduit in concrete by at least 2 inches on all sides.
- K. Where high voltage conduit or fiber duct is laid beneath the floor slab of a building, there shall be a minimum of 6 inches of sand fill between the outside of the concrete envelope around the conduit and the underside of the floor slab.
- L. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- M. Raceways embedded in slabs: Install in middle third of the slab thickness where practical and leave at least 1 inch concrete cover. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Place raceways laterally to prevent voids in concrete. Run conduit larger than one inch parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab.
- N. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor where equipment connections are not to be made under this contract, install screwdriver-operated threaded flush plugs flush with floor.
- O. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.
- P. Run exposed, parallel, or banked runs from the same centerline so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways be of the same size. In other cases provide field bends for parallel raceways.
- Q. Join raceways with fittings designed and approved for the purpose and make joints wrench tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or

- wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.
- R. Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside the box. Bushings on all conduit 1 inch and larger shall be insulating type.
 - S. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
 - T. Expansion fittings shall be used in all conduit runs crossing expansion joints, where required by NEC, or manufacturers recommendations.
 - U. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL 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 locations:
 - 1. Where conduits enter or leave hazardous locations.
 - 2. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air conditioned spaces.
 - 3. Where required by NEC.
 - V. Install pull wires in all empty raceways. Use monofilament plastic line having not less than 100 lb tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.
 - W. Seal spare and empty conduits with a conduit cap or plug to which the pull wire is attached.
 - X. Conduit fill: Do not exceed 30 percent conductor fill in conduits, containing branch circuit conductors. Do not exceed NEC requirements for all other conduits.
 - Y. Conductor derating: Derate conductor ampacity in accordance with NEC raceway fill requirements. Do not fill raceways so that conductor derating will exceed 50 percent.
 - Z. Provide boxes flush mounted in walls for switches, receptacles, telecommunications outlets, and manual motor starters.
 - AA. Provide rain-tight outlet boxes for interior and exterior locations exposed to weather or moisture.
 - BB. Install all boxes level and square.

- CC. Install switch boxes six inches from latch side of door openings.
- DD. Do not install aluminum products in concrete.
- EE. Do not install boxes back-to-back or use through-the-wall boxes.
- FF. Set floor boxes level and flush with finished flooring material.
- GG. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed boxes in concrete or masonry. Support boxes independently of conduit system.
- HH. Install cover plates and plug unused openings in boxes, raceways, cabinets, and equipment cases to afford protection equivalent to the wall of the equipment.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. The work of this section consists of providing labor, materials, tools, appliances and miscellaneous accessories for wiring device work indicated by Drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry but not utilize electric energy.
- B. Types of electrical wiring devices in this section include the following:
 - 1. Receptacles
 - 2. Ground-fault circuit interrupters
 - 3. Switches
 - 4. Wall plates
 - 5. Dimmers
 - 6. Plugs and connectors
 - 7. Floor service outlets

1.2 RELATED DOCUMENTS

- A. Drawings
- B. General Provisions of Contract, including General and Supplementary Conditions
- C. Division 01 - Specification Sections
- D. Section 16010 - Basic Electrical Requirements

PART 2 - PRODUCTS

2.1 FABRICATED WIRING DEVICES

- A. Manufacturer: Subject to compliance with requirements, manufacturers offering devices which may be incorporated in the work include, but are not limited to the following:
 - 1. Bryant Electric Co.
 - 2. Harvey Hubbell, Inc.
 - 3. Pass and Seymour, Inc.
 - 4. Raceway Components, Inc.
 - 5. Leviton Co.

6. Wiremold Company

- B. General: Provide factory-fabricated wiring devices, in types, colors, and electrical ratings for applications indicated and complying with NEMA Stds. Pub. No. WD 1. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements, and color devices and wallplates except as otherwise selected.
- C. Receptacles:
1. Duplex: Provide duplex "specification grade" receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke and mounting yoke provided with automatic grounding feature between mounting screws and yoke, 20-amperes, 125-volts, with metal plaster ears, back and side wiring, NEMA configuration 5-20R unless otherwise indicated. Pass & Seymour 5362 series (see below for color).
 2. Simplex: Provide simplex "specification grade" receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke and mounting yoke provided with automatic grounding feature between mounting screws and yoke, 20-amperes, 125 volts, with metal plate ears, (back and) side wiring, NEMA configuration 5-20R unless otherwise indicated. Pass & Seymour 5361 series (see below for color).
 3. Ground-Fault Interrupter: Provide "specification grade" duplex receptacles, ground-fault circuit interrupters (GFCI), feed-thru type, capable of protecting connected downstream receptacles on single-circuit, grounding type UL-rated Class A, 20-amperes rating, 120-volts, 60 Hz, with solid-state ground-fault sensing and signaling, with 5 milliampere ground-fault trip level; equip with 20-ampere plug configuration, NEMA 5-20R with local test/reset buttons and LED signal light to signify power is available. Pass & Seymour 2095 series (see below for color).
- D. Plugs and Connectors:
1. Plugs: Refer to drawings.
 2. Connectors: Refer to drawings.
- E. Switches:
1. Single Pole Toggle: Provide "specification grade" flush, quiet, AC-type, single-pole toggle switches, 20-amperes, 277/125 volts AC, with mounting yoke insulated from mechanism; equip with plaster ears, switch handle, side-wired screw terminals (and backwiring with clamp type terminals). Pass & Seymour PS20AC1 series (see below for color).

2. Double-Pole Toggle: Provide "specification grade" flush, quiet, AC type, double-pole toggle switches, 20-amperes, 277/125 volts AC, with mounting yoke insulated from mechanism, equip with plaster ears, switch handle, side-wired screw terminals (and backwiring with clamp type terminals) and ground screw. Pass & Seymour PS20AC2 series (see below for color).
3. Three-Way Toggle: Provide "specification grade" flush, quiet, AC-type, three-way toggle switches, 20-amperes, 277/125 volts AC, with mounting yoke insulated from mechanism, equip with plaster ears, switch handle, side-wired screw terminals (and backwiring with clamp type terminals). Pass & Seymour series PS20AC3 (see below for color).
4. Four-Way Toggle: Provide "specification grade" flush, quiet, AC-type, four-way toggle switches, 20-amperes, 277/125 volts AC, with mounting yoke insulated from mechanism; equip with plaster ears, switch handle, side-wired screw terminals (and backwiring with clamp type terminals). Pass & Seymour PS20AC4 series (see below for color).

2.2 DIMMERS

A. Controls

1. Dimmers shall provide full-range, continuously variable control of light intensity.
2. Controls shall fit a 1 inch wide, 1.5 inch tall wallplate opening with a vertical linear-slide. Controls shall be thin profile with no exposed heatsink/yoke. Unless otherwise specified, controls shall have a matte finish.
3. Controls shall provide a vertical slider allowing the light level or fan speed to be set by the user. "Slide-to-off" controls shall use the vertical slider to turn the control on and off.
4. "Preset" dimmers shall provide the on/off function independent of the dimmer slider position. This preset function shall be provided as a push on/push off switch integral to the slider knob and visibly distinct from the slider. For preset dimmers, when the lights are on, the slider shall change the light level and when the lights are off, the slider shall preselect the light level the lights will turn on to.
5. Control on/off function must be accomplished utilizing a mechanical air-gap switch to totally disconnect power from the load during "off" condition, no leakage current shall be present at the fixture(s).
6. Controls shall be able to have their visible plastic parts replaced, for color changes in the field, without removing the body of the control from the wall and without requiring special tools.
7. Within rated capacity, dimmers shall be available for direct control of incandescent, electronic low voltage, magnetic low voltage, and fluorescent. Matching fan-speed controls and switches shall also be available.
8. Controls shall be capable of operating at the rated capacity; this includes modified capacities for ganging configurations which require the removal of

fins. Operation at rated capacity shall be possible across the full ambient temperature range, without shortening design lifetime.

9. Dimmer shall provide smooth and continuous Square Law dimming curve, for the full slider travel, on their rated load per The IESNA Lighting Handbook
10. Controls shall meet the applicable requirements of UL 20 and UL 1472 referring to the inclusion of a visible, accessible air-gap off switch and the limited short circuit test.
11. Dimmers shall be designed to reduce interference with radio, audio, and video equipment.
12. Controls shall incorporate power-failure memory. Should power be interrupted and subsequently returned, the lights or fans will come back on to the same levels set prior to the power interruption. Restoration to some other default level is not acceptable.
13. Dimmer shall include voltage compensation to compensate light output for variation in the AC line-voltage. Dimmers in which the light output is not held constant with varying AC line-voltage shall not be acceptable.

B. Incandescent Dimmers

1. Provide incandescent dimmers for direct control of up to a full 20A lighting circuit, which is derated by 20% to 16 Amps per the NEC.
2. Dimmers shall have a high-end of no less than 95% of line voltage.
3. Dimmer shall be capable of operating in either 3-way switch location.

C. Electronic (Solid-State) Low Voltage (ELV) Transformer Dimmers

1. Dimmers shall contain circuitry specifically designed to control the input of electronic (solid state) low voltage transformers. Dimmers using standard phase control shall not be acceptable.
2. Provide ELV dimmers for direct control of up to 600 watts of electronic low voltage load.
3. Dimmers shall have a high-end of no less than 90% of line voltage.

D. Magnetic Low Voltage (MLV) Transformer Dimmers

1. Provide MLV dimmers for direct control of up to 1500VA of 120 volt magnetic low voltage load.
2. Provide MLV dimmers for direct control of up to 1000VA of 277 volt magnetic low voltage load.
3. Dimmers shall contain circuitry specifically designed to control and provide a symmetrical AC waveform to the input of magnetic low voltage transformers per UL1472 section 5.11.
4. Dimmers shall not cause a magnetic low voltage transformer to operate above the transformers rated operating current or temperature.
5. Dimmers shall have a high-end of no less than 95% of line voltage.

- E. Fluorescent Dimming Ballast Dimmers
 - 1. Provide Fluorescent dimmers for direct control of fluorescent dimming ballasts up to the manufacturers specified rating.
 - 2. Dimmers shall be designed to provide full ballast output at high-end.

- F. Remote dimming modules for high power loads
 - 1. Where lighting loads exceed the full rated capacity of single dimmers, provide an incandescent dimmer driving high power modules.
 - 2. High power modules shall be remotely mounted.
 - 3. High power module shall be rated and UL listed for control of incandescent, magnetic low voltage, electronic low voltage, fluorescent, and neon/cold cathode loads.

2.3 WIRING DEVICE ACCESSORIES

- A. Wall Plates: Provide wall plates for wiring devices, of types, sizes, and with ganging and cutouts as indicated on drawings (or schedules). Construct with metal screws with tamperproof heads for securing plates to devices, screw heads colored to match finish of plates. All aluminum plates shall be made of solid anodized aluminum (not painted aluminum). All plastic plates shall be high-impact, smooth nylon.

2.4 WIRING DEVICE FINISHES

- A. Provide device material and finish for outdoor locations, electrical rooms, mechanical rooms, work rooms, computer rooms, and equipment rooms according to the below list:
 - 1. Switches: White
 - 2. Switch Cover Plates: Nylon, White
 - 3. Receptacles: White
 - 4. Receptacle Cover Plates: Nylon, White
 - 5. Ground-Fault Interrupter: White
 - 6. Ground-Fault Interrupter Plates: Nylon, White
 - 7. Telephone Data Plates: Nylon, White

- B. Provide device material and finish for all other locations according to the below list:
 - 1. Switches: White
 - 2. Switch Cover Plates: Nylon, White
 - 3. Receptacles: White
 - 4. Receptacle Cover Plates: Nylon, White
 - 5. Ground-Fault Interrupter: White

6. Ground-Fault Interrupter Plates: Nylon, White
7. Telephone Data Plates: Nylon, White

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES/PLATES

- A. Install wiring devices as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work, including painting, electrical box and wiring work, as necessary to interface installation of wiring devices with other work, furniture locations, and door swings.
- C. Verify location of all devices with Architect before beginning construction.
- D. Install wiring devices only in electrical boxes which are clean, free from excess building materials, dirt, and debris.
- E. Install galvanized steel wall plates in unfinished spaces.
- F. Install weatherproof covers at all damp or exposed locations, as indicated on drawings.
- G. Delay installation of wiring devices until wiring work is completed.
- H. Delay installation of wall plates until after painting work is completed.
- I. Protect wiring devices during painting.
- J. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16" from the vertical or horizontal.
- K. All 20amp and 15amp, 3-wire receptacles shall be mounted with a "u" shaped grounding connection at the top, except for weatherproof receptacles.
- L. Provide monolithic cover plate for all switches and dimmer switches adjacent to each other.

3.2 PROTECTION OF WALL PLATES AND RECEPTACLES

- A. Upon installation of wall plates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

3.3 GROUNDING

- A. Provide electrically continuous, tight grounding connections for wiring devices, unless otherwise indicated. Tighten connections to comply with tightening torques specified in UL standard 486A to assure permanent and effective grounds.

3.4 TESTING

- A. Prior to energizing circuitry, test wiring devices for electrical continuity and proper polarity connections. After energizing circuitry, test wiring devices to demonstrate compliance with requirements.
- B. Sensitivity Test: After the sensor has been energized for at least 15 minutes, walk to the middle of the room (if conference room) or sit at the normal desk position (if and office). Make no motion for 20 seconds. Move one arm up and down slowly.
- C. Time Delay Test: Set the time delay for 10 minutes. Walk into the room to activate the sensor then leave room. Sensor must turn lights off at approximately 10 minutes. Walk into the room again to reactivate the lights. Lights should activate within 1 second.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level (within 1/16"). Mark all conductors with the panel and circuit number serving the device, at the device. Mark the panel and circuit number serving the device on the backside of the device plate with a permanent marking system that does not show through the front of the plate.

3.6 MOUNTING HEIGHTS

- A. Unless otherwise noted on the Drawings or required by the Architect, the following mounting heights shall apply:

Toggle Switches	48"CL	Vertical
Receptacles	18"CL	Vertical
Over Counter Receptacles	2.5" Above Splash Guard	Horizontal
Telephone Outlets:	18"CL	Vertical

- B. Upon approval of the Architect mounting heights may be adjusted.

END OF SECTION

SECTION 16145

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Section 16010 - Basic Electrical
 - 2. Section 16140 - Wiring Devices
 - 3. Section 16511 - Interior Lighting
- B. Extent of lighting control equipment work is indicated by drawings and schedules, and is hereby defined to include, but not by way of limitation, photocells, lighting contactors, and time switches.
- C. Types of lighting control equipment specified in this section include the following:
 - 1. Photocells
 - 2. Lighting Contactors
 - 3. Time Switches
 - 4. Lighting Control Panel
- D. Refer to other Division 16 Sections for wires/cables, electrical boxes and fittings, and wiring devices which are required in conjunction with lighting control equipment work; not work of this section.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's data on lighting control equipment and components.
- B. Maintenance Manuals: Furnish maintenance manuals which contain equipment cuts, operating instructions, troubleshooting procedures and spare parts list for equipment. Ensure manual includes operating instructions.

1.3 QUALITY ASSURANCE

- A. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with lighting control equipment work similar to that required for this project.
- B. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC as applicable to construction, installation of lighting control and communications equipment.
2. UL Compliance: Comply with applicable requirements of UL Std 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors". Provide lighting control equipment and components which are UL-listed and labeled.
3. NEMA Compliance: Comply with applicable requirements of NEMA's Stds Pub No. 250, "Enclosures for Electrical Equipment (1000-Volts Maximum)."

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver lighting control equipment and components in factory-fabricated type contains or wrappings, which properly protect equipment from damage.
- B. Store lighting control equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.
- C. Handle lighting control equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 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. Photocells:
 - a. Tork.
 - b. Intermatic.
 - c. Paragon.
 2. Lighting Contactors:
 - a. Siemens/ITE
 - b. Square D
 - c. Eaton
 - d. General Electric
 3. Lighting Control Panel
 - a. Watt-Stopper
 - b. Lutron
 - c. Sensor Switch
 4. Occupancy Sensors

- a. Watt-Stopper
- b. Lutron
- c. Leviton
- d. Sensor Switch

2.2 EQUIPMENT

A. PHOTOCELLS

1. Photocells shall be conduit mounted, 120 volt or 277 volt depending on the application, rated 2000 watts with single pole, single throw contacts.
2. Adjustment range 2 fc to 50 fc.
3. Photocell shall not be effected by moisture and operate from -40 deg C to +60 deg. C.
4. Photocell shall have manufacturer's 5 year warranty.

B. LIGHTING CONTACTORS

1. Mechanically held lighting contactors shall have 120 volt or 277 volt coils, coil clearing contacts, contacts rated 20 amperes at 277 volts, and number of poles as shown on the drawings or required. Contactors shall be furnished with NEMA 1 enclosure for surface mounting. Contactor shall be controlled by photocell.
2. Provide for manual override of photocell.

C. LIGHTING CONTROL PANEL

1. Description
 - a) Lighting Control Panels shall be UL listed and consist of the following:
 - i) Enclosure/Tub: NEMA 1.
 - ii) Cover: Surface or Flush as required, hinged, lockable and shall restrict access to line voltage section.
 - iii) Interior: Barrier for separation of high voltage (class 1) and low voltage (class 2) wiring. It shall include intelligence boards, power supply and control relays. Clock display and keypad shall be mounted on interior cabinet door for easy user access and programming.
2. Features
 - a) Panel shall accept up to 48 single pole relays. Relays shall be individual latching relays with 20 Amp load contacts for ballast (including HID, magnetic or electronic type ballasts), tungsten and general purpose loads. Provide isolated auxiliary contacts for pilot light switching. Relays shall use quick connectors and be individually replaceable to facilitate ease of use.
 - b) Where indicated, panels shall provide space within the high voltage section of the enclosure to accommodate up to 12 multi-pole contactors.

Two sections of DIN rail mounting shall be provided as standard. No field drilling or fabrication shall be required for mounting contactors or other accessories within the enclosure.

- c) The lighting control panel shall provide a stagger up delay, override push buttons, pilot light outputs, and LED status light indicators for each relay or contactor control channel.
- d) The clock shall have a backlight display, user keypad and shall provide 8 channels of time or astronomical control. Preprogrammed lighting control scenarios shall include: scheduled on/off, manual on/scheduled off, manual on/automatic switch sweep off, astronomic or photocell on/off and astronomic or photocell control with scheduled on/off. Time clock shall provide holidays, automatic daylight savings adjustment, astronomic coordinates by major cities, and help screens. Program memory shall be non-volatile and clock shall retain time keeping during power outages for at least 48 hours.
- e) The panel shall have 8 universal switch inputs that are low voltage, self-configuring and shall not require programming to accept momentary on/momentary off switch, push button switch (cycling), maintained switch or 24VDC signals from occupancy sensors, photocells or other interfacing devices.
- f) Occupancy sensor and time control shall be integrated to allow occupancy sensor control after hours with hold on of lighting during occupancy scheduled time. During occupied time, control scenarios shall be selectable for time schedule of lighting on or occupancy sensor detection of lighting on initially and then hold on of lighting during occupied hours. Control shall provide selectable occupancy sensor blink warning prior to shut off and adjustable occupancy sensor time delay from the time clock keypad.
- g) After-hour interior lighting shut off control shall provide a full duration override time of 1 to 240 minutes with a warning blink five minutes prior to shutting the lighting off. An impending shut off will be cancelled and the override period re-initialized through the operation of any assigned switch input.
- h) After-hour interior lighting shut off control may be by line voltage power interrupt control to automatic control switches. The lighting control relay panel shall provide a warning blink signal to automatic control switches, thus allowing a five-minute delay prior to shutting off lighting. The lighting shut off event may be cancelled by pressing the automatic control switch push button. The lighting control panel time clock shall provide periodic lighting sweep signals to shut off automatic control switches.

D. OCCUPANCY SENSORS:

1. Wall Mounted: The unit shall fit in/on a standard single gang switch box and require only two wires and a grounded box for operation. Rated capacity 1000

watts minimum at 120 volts, 60HZ for fluorescent lamps. Sensitivity shall be adjustable. The delay timer shall be adjustable with a range of 6 to 14 minutes minimum. The off switch shall have manual override for positive off and positive on. The test LED shall indicate motion. The area of coverage shall be approximately 170 degrees by 35-40 feet. The unit shall be UL listed for intended use. The color shall be white. The unit shall have a three year warranty.

- a) Sensors in Bathrooms: The sensor shall use ultrasonic detection method for detecting room occupancy.
 - b) Sensors in Offices: The sensor shall use passive infrared and ultrasonic (or microphonic) detection method for detecting room occupancy.
2. Ceiling Mounted: The sensor shall use passive infrared and ultrasonic detection method for detecting room occupancy. The unit shall fit in/on a standard octagon box. Rated capacity shall be 20 amps at 120 or 277 volts, for fluorescent lamps. The sensitivity shall be adjustable. The delay timer shall be adjustable 6 to 14 minutes minimum range. The coverage area shall be 360 degrees by approximately 15 feet radius when mounted at 9 foot height. The sensor shall have provisions, such as masking, to block out problem areas. Test LED to indicate motion. The unit shall be UL listed for intended use. The color shall be white. The unit shall have a three year warranty.

PART 3 - EXECUTION

3.1. EXAMINATION

- A. Examine areas and conditions under which lighting control equipment is to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.2. INSTALLATION

- A. Install lighting control system components and ancillary equipment as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that lighting control equipment complies with requirements. Comply with requirements of NEC, and applicable portions of NECA's Standard of Installation" pertaining to general electrical installation practices.
- B. Coordinate with other electrical work, including raceways, and electrical boxes and fittings, as necessary to interface installation of lighting control equipment work with other work.
- C. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not

indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B.

3.3. FIELD QUALITY CONTROL

- A. Upon completion of installation and after circuitry has been energized, demonstrate capability and compliance of system with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Testing and retesting at no cost to Owner.

3.4. DEMONSTRATION

- A. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating lighting control system equipment. Provide at least 3 hours of training.

END OF SECTION

SECTION 16289

SURGE PROTECTION 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 Surge Protection Devices for low-voltage power, control, and communication equipment.
- B. Related Sections include the following:
 - 1. Section 16140 - Wiring Devices
 - 2. Section 16470 - Panelboards
 - 3. Section 16441 - Switchboards

1.3 SUBMITTALS

- A. Drawings: Electrical and mechanical drawings shall be provided by the manufacturer which show unit dimensions, weights, mounting provisions, connection notes, wire size and wiring diagram.
- B. Equipment Manual: The manufacturer shall furnish an installation manual with installation notes, start-up and operating instructions for the specified system. Installation instructions shall clearly state whether the system requires an external overcurrent device to maintain the system's UL 1449 listing.
- C. Independent Testing:
 - 1. High exposure with the 10 x 1,000 μ s tests per IEEE C62.41.2 Section 7.2
 - 2. Life Cycle/Repetitive Testing per C62.45-2002 section B.38 minimum of 1,000 to 2,000 times
 - 3. Additional testing may be required for per phase or per mode fused products with a 200kA or 100kA per phase per IEEE C62. Products must be on line and function after surge test.
- D. NEC, Section 285 - Installation requirements for SPD.
 - 1. Section 285.2, SPD must limit transient voltage by diverting or limiting surge current; it also should prevent continued flow of follow current while remaining capable of repeating these functions. SPD that utilize fuses must have repetitive surge capability that can survive its surge rating and meet UL 1449.
 - 2. Section 285.6, SPD shall be marked with a short circuit current rating and shall

not be installed at a point on the system (ex. service, distribution or branch panels) where the available fault current (AIC rating) is in excess of that rating.

- E. UL 1449 stipulation for fused SPD - The manufacturer's authorized representative is required to submit the following:
 - 1. Certify that the SPD system is UL 1449 listed with UL Card.
 - 2. Indicate the type of internal or external fusing that is incorporated in the SPD system and what impact the fusing has on the performance of the device with respect to surge capacity and clamping levels.
- F. CBEMA (ITIC) & IEC - SVRs must meet voltage tolerance guidelines SVR clamp levels for wye and single phase (L-N, L-G and N-G): 400-600V for 120V systems, 800-1200V for 277V systems and 1200-1500V for 347V systems SVR clamp levels for delta circuits (L-L and L-G): 1000-1200V for 240V systems, 1500-1800V for 480V systems and 1800-2000V for 600V systems

1.4 STANDARDS

- A. UL 1449 2nd edition or current safety standard for Surge Protection Devices
UL 1283 listed as an electromagnetic interference filter that provides noise attenuation) UL 67 internal integration of SPD in panelboard
- B. National Electric Code
 - 1. Article 250.56 Grounding
 - 2. Article 285, SPD Installation Practice
- C. NFPA 78
- D. ISO 9001:2000 - QUALITY STANDARD
- E. IEEE (Institute of Electrical and Electronic Engineering Inc.) C62.41.1 and C62.41.2
 - 1. IEEE C62.41.2, Section 7.2 long duration 10 x 1,000 μ sec test to be compliant if the device exhibits less than 10% deviation from initial readings. Units must be tested to withstand and pass the 10 x 1,000 μ sec test
 - 2. IEEE C62.45 (system shall be tested to meet the C62.45)
 - 3. Category A & B - (0.5 μ s x 100 kHz ring wave)
 - 4. Category B3 bi-wave - (8 x 20 μ s at 3,000 amperes and 1.2 x 50 μ s at 6,000 volts)
 - 5. Category C3 bi-wave - (8 x 20 μ s at 10,000 amperes and 1.2 x 50 μ s at 20,000 volts)
- F. The fusing elements must be capable of allowing the suppressor's rated single impulse current to pass through the suppressor at least one time without failure. The system shall be tested to 1,000 sequential per C62.45-2002 section B.38 referencing C62.41.1 and C62.41.2 category C3 combination wave transients. The category C3 combination wave is defined as a 1.2 x 50 microsecond wave at 20,000 volt open circuit voltage waveform and 8 x 20 microsecond wave at 10,000

ampere short circuit current waveform. In addition, the system components shall be tested repetitively 1,000 times testing based on an IEEE C62.33 (MOV test) and C62.35 (SAD test) without failure or degradation exceeding $\pm 10\%$.

- G. CBEMA (ITIC) and IEC - (Computer Business Equipment Manufacturers Association or Information Technology Industry Council and International Electrotechnical Commission define clamping voltage tolerance guidelines for sensitive equipment)
- H. All manufacturers must comply with above listed standards and any additions current revisions of industry standards. All products that do not comply with current industry standards will not be accepted.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

1.6 PROJECT CONDITIONS

- A. Placing into Service: Do not energize or connect service entrance equipment or panelboards to their sources until the surge protective devices are installed and connected.
- B. Each protection device shall have a capacitive filtering system connected in each Line to Neutral (L→N)(Wye) mode or Line to Line (L→L)(Delta) mode to provide EMI/RFI noise attenuation (UL 1283).
- C. Protection modes: The SPD shall provide Line to Neutral (L→N)(Wye), Line to Ground (L→G)(Wye or Delta), Line to Line (L→L)(Delta) and Neutral to Ground (N→G)(Wye) protection.
- D. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
 - 3. Humidity: 0 to 85 percent, noncondensing.
 - 4. Altitude: Less than 20,000 feet (6000 m) above sea level.

1.7 COORDINATION

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

- B. Coordinate surge protective devices with Division 16 Section "Electrical Power Monitoring and Control."

1.8 WARRANTY

- A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Manufacturer shall provide a product warranty for a period of not less than five (5) years from date of installation. Warranty shall cover unlimited replacement of SPD modules during the warranty period. Those firms responding to this specification shall provide proof that they have been regularly engaged in the design, manufacturing and testing of SPD for not less than twenty (25) years.
- C. Special Warranty for Plug-in Cord-Connected Surge Suppressors: Written warranty, executed by manufacturer agreeing to repair or replace electronic equipment connected to circuits protected by surge suppressors.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND MODELS

- A. CURRENT TECHNOLOGY
- B. LEA INTERNATIONAL INC.
- C. LIBERT

2.2 SERVICE ENTRANCE SUPPRESSORS

- A. Equipment shall Equipment shall be a multi-stage parallel protector rated for 208Y/120V. Please see online diagram and panelboard schedule to confirm voltages. The equipment's minimum surge current capacity shall be 120kA per phase (L-N plus L-G) and 60kA per mode (L-N, L-G, L-L and N-G).
- B. The system protection modules shall contain a technology that utilizes a symmetrical array of balanced metal oxide varistors (MOV). Each MOV will be individually coordinated to pass UL 1449.
- C. All primary transient paths shall utilize copper wire, aluminum bus bar and lugs of equivalent capacity to provide equal impedance interconnection between phases. No plug-in module or components shall be used in surge carrying paths.
- D. Each protection module shall have a visual indicator that signifies that the protection circuitry is on line. The unit shall not be taken off line to verify integrity of system. Redundant status indicators shall be mounted on the front of the door

that monitors the system protection circuitry.

- E. The system shall be modular with field replaceable modules. Modular units shall contain a minimum of one module per phase.
- F. Equipment shall provide the following monitoring features: dry contacts, digital surge counter and audible alarm with alarm disable switch. Equipment shall utilize a NEMA 4 or NEMA 12 enclosure.

2.3 PANELBOARD SUPPRESSORS & AUXILIARY PANEL SUPPRESSORS

- A. Device shall meet all specification requirements in section 2.1 except as follows:
Equipment shall be a multi-stage parallel protector rated for 208Y/120V. Please see online diagram and panelboard schedule to confirm voltages. The equipment's minimum surge current capacity shall be 120kA per phase (L-N plus L-G) and 60kA per mode (L-N, L-G, L-L and N-G).
 - 1. The system protection shall contain a technology that utilizes a symmetrical array of balanced metal oxide varistors (MOV). Each MOV will be individually coordinated to pass UL 1449. The unit shall be non-modular type.
 - 2. Equipment shall provide the following monitoring features: dry contacts, surge counter and audible alarm with alarm disable switch.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

- A. The specified service entrance/switchboard/switchgear system shall be installed with the shortest lead length possible not to exceed five (5') electrical feet from the power conductor(s) it is protecting, must have a grounding of 25 Ohms (NEC Article 250.56) or less and shall avoid any unnecessary or sharp bends. Utilize a 3 pole 60 amp breaker for connection means.
- B. The specified branch panelboard system shall be installed with the shortest lead length possible not to exceed a foot and half (1.5') electrical feet from the power conductor(s) it is protecting, must have a grounding of 25 Ohms (NEC Article 250.56) or less and shall avoid any unnecessary or sharp bends. Utilize a 3 pole 30 or 60 amp breaker for connection means. See manufacturer's installation manual.

3.2 CONNECTIONS

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

3.3 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:

1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements.
 2. Complete startup checks according to manufacturer's written instructions.
 3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.
- B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

END OF SECTION

SECTION 16410

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1-GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Feeder and equipment disconnects
 - 2. Enclosed circuit breakers
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Section 16491 - Fuses

1.2 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for switches, circuit breakers, and accessories specified in this Section.
- C. Descriptive data and time-current curves for protective devices and let-through current curves for those devices with current-limiting characteristics. Include coordination charts and tables, and related data.

1.3 QUALITY ASSURANCE

- A. Comply with NEC for components and installation.
- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
- C. Single-Source Responsibility: All enclosed switches and circuit breakers shall be the product of a single manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements provide products from the following manufacturers or equivalent

1. Fusible Switches:
 - a. Square D
 - b. GE
 - c. Eaton
2. Molded-Case Circuit Breakers:
 - a. Square D
 - b. GE
 - c. Eaton

2.2 MATERIALS

A. ENCLOSED SWITCHES

1. Enclosed Non-fusible Switch: NEMA KS 1, Type HD, handle lockable with 2 padlocks.
2. Enclosed Fusible Switch, 800 Amperes and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.
3. Enclosure: See plan.

B. ENCLOSED CIRCUIT BREAKERS

1. Enclosed Molded-Case Circuit Breaker: NEMA AB 1, handle lockable with 2 padlocks.
2. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated; interrupting capacity rating to meet available fault current, 35,000 symmetrical RMS amperes minimum. With appropriate application listing when used for switching fluorescent lighting loads or heating, air conditioning, and refrigeration equipment.
3. Interchangeable Trips: Circuit breakers, 200 amperes and larger, with trip units interchangeable within frame size.
4. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
5. Shunt Trip: Where indicated, 120 volts, 60 Hz.
6. Enclosure: See plan

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install enclosed switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.
- B. Install enclosed switches and circuit breakers level and plumb.
- C. Install wiring between enclosed switches and circuit breakers and control/indication devices.
- D. Disconnects shall be mounted at 6'-6" AFF to top of enclosure in accessible areas, unless otherwise indicated.

- E. Fusible disconnects shall not be mounted over 12 feet AFF. Unless otherwise indicated.
- F. Disconnects mounted on equipment higher than 12 feet AFF, shall be non-fused. Fusing protection must be provided in a more readily accessible location.
- G. All motors shall have a disconnecting means with in sight of, and not more than 20 feet from motor.
- H. Provide a "Lock-Out" means at disconnect for all motors, at disconnect nearest motor/equipment.
- I. Connect enclosed switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts according to equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

3.2 FIELD QUALITY CONTROL

- A. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.5 for enclosed switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
- B. Verify all interlock devices (mechanical and electrical) are in place and working correctly.
- C. Correct malfunctioning units at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

3.3 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

3.4 DEMONSTRATION

- A. Review data in the "Operating and Maintenance Manual." Refer to Division 1 Section "Project Closeout."

END OF SECTION

SECTION 16461

TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. The work of this section consists of providing labor, materials, tools, appliances and miscellaneous accessories associated with the transformer work indicated herein and on the Drawings.

1.2 RELATED DOCUMENTS

- A. Drawings
- B. General provisions of Contract, including General and Supplementary Conditions
- C. Division 01 - Specification Sections
- D. Section 16010 - Basic Electrical Requirements

1.3 QUALITY ASSURANCE

- A. The manufacturer of the transformer must be the same as the manufacturer of the substations and panelboards.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products of one of the following or equivalent (for each type of transformer):
 - 1. Square D
 - 2. GE
 - 3. Eaton

2.2 TRANSFORMERS, GENERAL

Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.

2.3 GENERAL PURPOSE DRY TYPE TRANSFORMERS

- A. Comply with NEMA Standard ST 20 "Dry-Type Transformers for General Applications".
- B. Windings: 2-winding type. Three phase transformers shall use one coil per phase in primary and secondary.
- C. Provide all copper windings.
- D. FEATURES & RATINGS
 - 1. Enclosures:
 - a. Indoor - ventilated, drip-proof.
 - b. **Outdoor - totally enclosed, non-ventilated, suitable for outdoor use.**
 - 2. Insulation Class: 185 degree C class for transformers 15 KVA or smaller; 220 degree C class for transformers larger than 15 KVA.
 - 3. Insulation Temperature Rise: 115 degree C maximum rise above 40 degree C, for 220 degree C class insulation, unless otherwise noted on drawings and 115 degree C maximum rise for 185 degree C class insulation.
 - 4. Taps: For transformers 3 KVA and larger, full capacity taps in high-voltage winding as follows:
 - a. 3 KVA through 10 KVA: Two 5 percent taps below rated high-voltage.
 - b. 15 KVA through 300 KVA: Six 2-1/2 percent taps, 2 above and 4 below rated high-voltage.
 - c. 500 - 1000 KVA: Four 2-1/2 percent taps, 2 above and 2 below rated high-voltage.
 - 5. Isolate core and coil from enclosure using vibration - absorbing mounts.
 - 6. Efficiency Ratings: Minimum 97% from 35% of full load to 100% full load conditions and meet shall be TP1 rated.
- E. ACCESSORIES
 - 1. Wall mounting brackets: Manufacturers standard brackets for transformers sized up to 75 KVA where wall mounting is indicated.
- F. SOUND LEVELS
 - 1. Sound levels shall be warranted by the manufacturer not to exceed the following:
 - a. 15 to 50KVA - 50dB
 - b. 51 to 150kVA - 55dB
 - c. 151 to 300kVA - 60dB

PART 3 - EXECUTION

3.1 INSTALLATION OF TRANSFORMERS

- A. Install transformers as indicated, complying with manufacturer's written instructions, applicable requirement of NEC, NEMA, ANSI and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- C. Install units on vibration mounts; comply with manufacturer's indicated installation method if any.
- D. Connect transformer units to electrical wiring system; comply with requirements of other Division 16.
- E. Install label nameplate as required.
- F. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A and B.
- G. Floor mounted transformer to be mounted on housekeeping pad.

3.2 GROUNDING

- A. Provide equipment grounding connections for power/distribution transformers as required and/or indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounding.
- B. Provide service grounding electrodes and connections as required by the NEC 2005 Edition for a separately derived electrical system.

3.3 TESTING

- A. Prior to energization of transformers, check all accessible connections for compliance with manufacturer's torque tightening specifications.
- B. Prior to energization, check circuitry for electrical continuity, and for short-circuits.
- C. Upon completion of installation of transformers, energize primary circuitry at rated voltage and frequency from normal power source, and test transformers, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements, where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units or components, and proceed with testing.

END OF SECTION

SECTION 16470

PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. The work of this section consists of providing labor, materials, tools, appliances and miscellaneous accessories associated with panelboard work indicated herein and on the Drawings and schedules.
- B. Types of panelboards and enclosures required for this project include the following:
 - 1. Power-distribution panelboards.
 - 2. Lighting and appliance panelboards.
- C. Extent of panelboard work is indicated by Drawings and schedules

1.2 RELATED DOCUMENTS

- A. Drawings.
- B. General provisions of Contract, including General and Supplementary Conditions.
- C. Division 01 - Specification Sections.
- D. Section 16010 - Basic Electrical Requirements.

1.3 EQUIPMENT LOCKS

- A. All panelboards, cabinets and other electrical equipment having doors with locks, shall be keyed alike.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products of one of the following for each type of panelboard and enclosure:
 - 1. General Electric
 - 2. Siemens
 - 3. Square D
 - 4. EATON

2.2 CONSTRUCTION

- A. General: Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials, design and construction in accordance with published product information; equip with number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL and established industry standards for applications indicated.
- B. Lighting and appliance panelboards shall be dead front safety-type equipped with molded case circuit breakers as shown and scheduled.
- C. Main lugs or main overcurrent units shall be furnished for panelboards as indicated on the Drawings.
- D. The number of branches in each panel shall be as indicated on the Drawings.
- E. Panelboards shall be mounted in code gauge galvanized sheet steel cabinets with corners lapped and riveted or fastened by other approved methods. Cabinets shall be of such size as to allow a wiring gutter space of at least 6" all around for power panels, and 4" all around for lighting panels. Extra large gutter spaces shall be provided if specifically called for.
- F. Panelboards shall be flush or surface mounted as indicated on the Drawings. Trim for each panel shall be suitable for the type of mounting. Each trim shall be complete with suitable hinged door having chrome plated flush type combination lock and catch, except that for doors over 48" in height a chrome plated vault handle and 3 point catch shall be provided with built-in lock arranged to fasten door at top, bottom and center. Two keys shall be provided for each lock and each key shall open all panelboards furnished. All trims shall be of a type that is self-supporting on the box after the trim holding screws have been removed. All free-standing cabinets shall be secured to floors, walls, and columns with approved angle iron or unistrut framework. Framework shall be painted as cabinets.
- G. Each panelboard shall be complete with main copper or aluminum bus run up the center and neutral bars where required and all proper sequence phase connections. Polarized panelboards will not be accepted. Capacities of copper busses and connections shall be based on a maximum density of 1000 amps. per sq. in. Spacing of busses shall not be less than code requirements. Busses shall be arranged for single or 3-phase, 3- or 4-wire supply as indicated on the Drawings. Busses shall be provided with suitable phase identification.

- H. Directory holder with metal frame shall be furnished and installed upon of door of each cabinet, with complete typewritten circuit schedule inserted.
- I. The inside and outside of panelboard boxes, doors and trims shall be furnished with at least two coats of manufacturer's standard finish paint over a baked-on prime cost.
- J. Provide ground bus. Provide additional isolated ground bus where specified.
- K. Series rated panelboards shall not be used.

2.3 LIGHTING AND BRANCH CIRCUIT PANELBOARDS

- A. Panels shall be for use on 4-wire, 60 cycle, solid neutral service, with number and size of bolt-on type circuit breaker branches as shown on the Drawings. Circuit breaker's interrupting capacity shall match the panels rating. Refer to plans for panel rating.

2.4 POWER AND DISTRIBUTION PANELBOARDS

- A. Distribution, Lighting and Appliance Panelboards: Provide dead-front safety constructed factory assembled circuit breaker type panelboards in sizes and ratings as indicated. Construct with plated rectangular shaped aluminum or copper bus bars, which are securely mounted and braced, and with lugs bolted to main bus bars. Provide anti-turn solderless pressure type lug connectors approved for copper conductors, for connecting feeders. Provide full-sized neutral bus bar with suitable lugs for circuits requiring neutral connection. Provide main and branch circuit breakers. Breakers should be molded case bolt-in type, heavy-duty, quick-make, quick-break, with toggle handles that indicate when tripped. Where multiple breakers are indicated, provide with common trip so that overload on one pole will trip all poles simultaneously. Provide suitable lugs on neutral bus for each outgoing feeder required; provide bare un-insulated grounding bars suitable for bolting to enclosures with suitable lugs for incoming and outgoing equipment grounding conductors. Load center type panelboards are not acceptable.
- B. For multiple section panelboards, route the grounding conductor full size from ground buss to ground buss. Metal to metal cabinet grounding is not solely sufficient. The buss rating shall be continuous through each section, not tapered or diminished in size or rating. Cable from one section to another shall be full capacity and not reduced.

2.5 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a) Instantaneous trip
 - b) Long- and short-time pickup levels
 - c) Long- and short-time time adjustments
 - d) Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated with field-adjustable 0.1- to 0.6-second time delay.
 5. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.6 SPD DEVICES

- A. IEEE C62.41, integrally mounted, plug-in style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules where specified on drawings.
- B. Minimum single-impulse current rating shall be as follows:
 1. Line to Neutral: 120,000 amp
 2. Line to Ground: 120,000 amp
 3. Neutral to Ground: 60,000 amp
- C. Protection modes shall be as follows:
 1. Line to neutral
 2. Line to ground
 3. Neutral to ground
- D. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.

- E. Category C combination wave clamping voltage shall not exceed 600 V, line to neutral and line to ground on 120/208 V systems.
- F. UL 1449 clamping levels shall not exceed 400 V, line to neutral and line to ground on 120/208 V systems.
- G. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.
- H. Accessories shall include the following:
 - 1. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
 - 2. Audible alarm activated on failure of any surge diversion module.
 - 3. Six-digit transient-counter set to totalize transient surges that deviate from the sine-wave envelope by more than 125 V.

2.7 POWER METER

- A. True RMS sensing at a minimum of 300 samples per cycle on all channels simultaneously
- B. Programmable voltage and programmable current to any available CT Ratio
- C. Visual Display
- D. Measuring Parameters & Accuracy
 - 1. Voltage, Watts, Wh, VARs, VARh, VA, Vah, PF: 0.2%
 - 2. Frequency: 0.01Hz
 - 3. %THD: 5%
 - 4. %Load Bar: 1-120%
 - 5. ANSI C12.20 & IEC 687 accuracy classes
- E. Refresh Rate
 - 1. Watts, VAr, and VA: minimum 200 milliseconds
 - 2. All other parameters: minimum 1.5 seconds
- F. Communications
 - 1. 2 Com Ports
 - 2. RS485 Output
 - 3. Modbus RTU connection
 - 4. Modbus ASCII or DNP 3.0 connection
- G. Withstand Capabilities:

1. IEEE C37.90.1
2. Isolated inputs and outputs to 2500 volts.
3. NEMA 12 mounting gasket

H. -20 degrees Celsius to 60 degrees Celsius operating temperature

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELBOARDS

- A. General: Install panelboards and enclosures where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate installation of panelboards and enclosures with cable and raceway installation work.
- C. Anchor panelboard assemblies firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.
- D. Provide properly wired electrical connections for panelboards within enclosures.
- E. Fill out (typewritten) panelboard's circuit directory card upon completion of installation work.
- F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and B.
- G. Provide filler plates for unused spaces in panelboard.

3.2 GROUNDING

- A. Provide equipment grounding connections for panelboard enclosures as indicated. Tighten connections to comply with UL tightening torques to assure permanent and effective grounds.

3.3 FIELD QUALITY CONTROL

- A. Prior to energization of panelboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.

- B. Prior to energization, check panelboards for electrical continuity of circuits, and for short-circuits.
- C. Prior to energization of circuitry, check all accessible connections to manufacturers tightening torque specifications.

3.4 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finishes.

3.5 DEMONSTRATION

- A. Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.
- B. Label panelboards in accordance with Division 16195.

END OF SECTION

SECTION 16491

FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Fuses.
 - 2. Spare fuse cabinet.
- B. Related section includes the following:
 - 1. Section 16410 - Enclosed Switches and Circuit Breakers

1.2 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for each fuse type. Include the following:
 - 1. Descriptive data and time-current curves.
 - 2. Let-through current curves for fuses with current limiting characteristics.
 - 3. Coordination charts and tables and related data.

1.3 QUALITY ASSURANCE

- A. Comply with NEC for components and installation.
- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
- C. Single-Source Responsibility: All fuses shall be the product of a single manufacturer.

1.4 MAINTENANCE

- A. Furnish the following extra materials that match products installed, packaged with protective covering for storage, and with identification labels clearly describing contents.

- B. Spare Fuses: Furnish quantity equal to one unit for every 5 units of each fuse type and size installed, but not less than 1 set of 3 of each type and size.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

A. Cartridge fuses

1. Fuses

- a. All fuses: 200,000 AIC at rated AC or DC voltage.
- b. Fuses 1/10 through 600 A.:
- (1) UL Class: RK- 1, time delay
 - (2) Maximum operating temperature: 300 deg. F.
 - (3) Self protecting thermally.
 - (4) Separate overload and short circuit element.
 - (5) Incorporate a spring-activated "snap-trigger" thermal overload element responsive to fuse temperatures exceeding 284 deg. F.
- c. Fuses 601 to 6,000 A.:
- (1) UL Class: L, time delay.
 - (2) Pure silver links.
 - (3) "O" ring seal.
 - (4) 600 V. or less AC.
 - (5) 250 V. or less DC.
- d. Control Circuit Fuses:
- (1) UL Class CC.
 - (2) Dual element, time delay.

B. Plug fuses

1. Type: UL 198F, Type S, dual element, time delay.
2. Edison base fuses shall not be used.

C. Spare fuse cabinet

1. Cabinet: Wall-mounted, 18-gage minimum steel unit with full-length, recessed piano-hinged door with key-coded cam lock and pull.
2. Size: Adequate for orderly storage of spare fuses specified with 15 percent spare capacity minimum.
3. Finish: Gray baked enamel.
4. Identification: Stencil legend "SPARE FUSES" in 1-1/2-inch (40-mm) letters on door.
5. Locate cabinets in main electrical rooms and penthouses.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses in fusible devices as indicated. Arrange fuses so that fuse ratings are readable without removing fuse.

END OF SECTION

SECTION 16511

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent, location, and details of interior lighting fixture work are indicated on drawings and in schedules.
- B. Types of interior lighting fixtures in this section include the following:
 - 1. High-intensity-discharge (HID)
 - 2. Fluorescent.
 - 3. Incandescent.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions on each type interior building lighting fixture and component.
- B. Shop Drawings: Fixture shop drawings with ballast manufacturer information in booklet form with separate sheet for each fixture, assembled in "luminaire type" alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet. Submit details indicating compatibility with ceiling grid system. Submit locations of remote ballasts when specified.

1.3 QUALITY ASSURANCE

- A. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects with interior lighting fixture work similar to that required for this project.
- B. Codes and Standards:
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 220, 410, and 510 as applicable to installation, and construction of interior building lighting fixtures.
 - 2. NEMA Compliance: Comply with applicable requirements of NEMA LE 1 and LE 2 pertaining to lighting equipment.
 - 3. IES Compliance: Comply with IES RP-1 pertaining to office lighting practices and RP-15, regarding selection of illuminance values for interior office lighting.
 - 4. UL Compliance: Comply with UL standards, including UL 486A and B, pertaining to interior lighting fixtures. Provide interior lighting fixtures and components which are UL-listed and labeled.

5. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.
 - C. Coordination of Fixtures with Ceiling and exposed structure areas: Coordinate fixtures mounting hardware and trim with the ceiling system.
 - D. Manufacturers Qualifications: Firms experienced in manufacturing fixtures that are similar to those indicated for this Project and that have a record of successful in-service performance.
- 1.4 DELIVERY, STORAGE AND HANDLING
- A. Deliver interior lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from damage.
 - B. Store interior lighting fixtures in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, laid flat and blocked off ground.
 - C. Handle interior lighting fixtures carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.
- 1.5 SEQUENCING AND SCHEDULING

PART 2 - PRODUCTS

2.1 BALLAST MANUFACTURERS

- 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 manufactures listed on the lighting fixture schedule and the following:
 1. Bodine
 2. Advance
 3. Universal
 4. Lutron
 5. General Electric

2.2 EQUIPMENT

A. FIXTURES

1. Comply with the requirements specified in the Articles below and lighting fixture schedule.

2. General: Provide lighting fixtures, of sizes, types and ratings indicated; complete with, but not limited to, housings, energy-efficient lamps, lamp holders, reflectors, energy efficient ballasts, starters and wiring. Ship fixtures factory-assembled, with parts required for a complete installation. Design fixtures with concealed hinges and catches, with metal parts grounded as common unit, and so constructed as to dampen ballast generated noise.
 3. Metal Parts: Free from burrs, sharp edges, and corners.
 4. Doors, Frames, and Other Internals Access: Smooth operating and free from light leakage under operating conditions. Arrange to permit re-lamping without use of tools, except where specified to be tamper resistant. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during re-lamping and secured in the operating position.
 5. Lenses, Diffusers, Covers, and Globes: 100 percents virgin acrylic plastic or water white, annealed crystal glass except as indicated.
 - a. Plastic: Highly resistant to yellowing and other changes due to aging, exposure to heat and UV radiation.
 - b. Lens Thickness: 0.125 inches, minimum
- B. SUSPENDED FIXTURE SUPPORT COMPONENTS
1. Rod Hangers: 3/16 inch diameter cadmium plated, threaded steel rod.
 2. Hook Hanger: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking type plug.
- C. FLUORESCENT FIXTURES
1. Electronic Ballasts: Solid-State, full light output, energy saving type. Conform to FCC rules Part 15, subpart J for electromagnetic interference. Conform to IEEE C62.51, "Guide for Surge Voltages in Low-Voltage AC Power Circuits," Category A, for resistance to voltage surges for normal and common modes.
 - a. Ballast shall operate the lamps at a frequency of 25 KHz or higher with less than 2% lamp flicker.
 - b. Ballast shall operate at an input voltage of 108 to 132 (120V circuit) at an input frequency of 60 Hz. Light output shall remain constant for line voltage fluctuation of +- 5%.
 - c. Ballast shall have a guaranteed minimum power factor of 0.90. (PF = Watts/Volt-Amps).
 - d. Ballast shall not contain PCBs.
 - e. Ballast shall have less than 1.5 lamp current crest factor for rapid start and less than 1.7 for instant start. (Crest factor is defined as lamp peak current divided by lamp RMS current).
 - f. Ballast shall have less than 10% total harmonic distortion.

- g. Ballast shall be better than 90% efficient (power out/power in).
- h. Ballast noise shall be better than sound rated A. (No audible noise)
- i. Ballast must be Underwriters Laboratories (UL) listed Class P
- j. Ballasts shall be individually fused.
- k. Ballast shall have 5 years minimum replacement warranty. Warranty shall include labor for replacement.
- l. Maximum inrush current shall be 20 times rated current or less.
- m. Ballast shall be rapid start, and parallel wired operation.

2. Fluorescent Lamps: Shall contain less than 100 pictograms of mercury per lamp.

D. HIGH INTENSITY DISCHARGE (HID) FIXTURES

1. High-Intensity Discharge-Lamp Ballasts:

- a. Provide HID lamp ballasts, of ratings, types and makes as recommended by lamp manufacturer. Ballasts shall be type Constant Wattage Auto Transformer, 1 phase, 60 hertz, high power factor with wattage regulation for low in-rush current characteristics.
- b. Ballast's for HID lamps shall have the lowest sound rating available for each ballast type.
- c. Core and coil ballasts shall be encapsulated type with high thermal conductivity potting material.
- d. Ballasts shall be individually fused. Fuse ratings shall be based on 2-1/2 times the rated nominal operating line current.

2. Mercury fixtures are not acceptable.

E. INCANDESCENT FIXTURES

1. Conform to UL 1571, "Incandescent Lighting Fixtures."

F. TRACK LIGHTING SYSTEMS

1. Conform to UL 574, "Track Lighting Systems." Provide components, including track, fittings, and fixtures from same manufacturer, and as recommended by the manufacturer for the intended purpose.

G. LAMPS

1. Provide all lamps as listed in the fixture schedule on the drawings or as described here under.
2. All lamps shall be low mercury type when available.
3. Incandescent lamps for general service, inside-frosted, wattage at 130 volt as noted on the lighting fixture schedule.
4. Minimum lamp life ratings (hours):

- a. Linear Fluorescent 20,000
- b. Compact Fluorescent 10,000
- c. Metal Halide 10,000
- d. High Pressure Sodium 15,000
- e. Incandescent 2,000

5. Metal halide lamps shall be clear or coated with CRI above 65.

H. EMERGENCY INTERIOR LIGHTING FIXTURES

1. Emergency egress and exit lighting for buildings shall be supplied via individual battery units. These units shall be the self test and diagnostic types.
 - a. Fluorescent battery pack units shall be Bodine B50ST, 1100 Lumens, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which lighting fixtures are to be installed, and substrate for supporting lighting fixtures. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

- A. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- B. Setting and Securing: Set units plumb, square, and level with ceiling and walls, and secure according to manufacturers printed instructions and approved shop drawings.
- C. Recessed Fixtures: Installed units may be supported from suspended ceiling support system. Install ceiling system support rods or wires at a minimum of four rods or wires per fixture located not more than 6 inches from fixture corners.
 1. Fixtures Smaller Than Ceiling Grid: Install a minimum of four rods or wires for each fixture and locate at corner of the ceiling grid where the fixture is located. Do not support fixtures by ceiling acoustical panels.
 2. Fixtures of Sizes Less than Ceiling Grid: Center in the acoustical panel. Support fixtures independently with at least two $\frac{3}{4}$ inch metal channels spanning and secured to the ceiling tees.
 3. Install support clips for recessed fixtures, securely fastened to ceiling grid members, at or near each fixture corners.

- D. Light fixtures in suspended ceiling systems shall be positively attached to the ceiling system using screws or manufacturer supplied clips, in accordance with manufacturer written instructions. When using screws avoid bending fixture frame. Minimum of four attachment points, additional if required.
- E. Light fixtures in suspended ceiling systems shall be connected with a flexible wiring method. Provide additional length to allow the fixture to be moved two feet in any direction.
- F. Provide fixtures and/or fixture outlet boxes with hangers to properly support fixture weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by Architect.
- G. Install flush mounted fixtures to eliminate light leakage between fixture frame and finished surface.
- H. Provide plaster frames for recessed fixtures installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.
- I. For air supply type fixtures, retain side slot closures in place for adjustment by Balancing Contractor.
- J. Fasten fixtures securely to indicated structural supports; and ensure that pendant fixtures are plumb and level. Provide individually mounted pendant fixtures longer than 2 feet with twin stem hangers. Provide stem hanger with ball aligners and provisions for minimum 1" vertical adjustment. Mount continuous rows of fixtures with an additional stem hanger greater than number of fixtures in the row.
- K. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B, and the National Electrical Code.
- L. Support surface mounted fixtures greater than 2 feet in length at a point in addition to the outlet box fixture stud.

3.3 FIELD QUALITY CONTROL:

- A. At Date of Substantial Completion, replace lamps in interior lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by Architect.
- B. Furnish stock or replacement lamps amounting to 10%, but not less than 4 lamps in each case, of each type and size lamp used in each type fixture. Deliver replacement stock as directed to Owner's storage space.

3.4 ADJUSTING AND CLEANING

- A. Clean interior lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses.
- B. Protect installed fixtures from damage during remainder of construction period.

3.5 DEMONSTRATION

- A. Upon completion of installation of interior lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION

SECTION 16716

COMMUNICATIONS

PART 1 - GENERAL

1.1. SCOPE

Provide and install a complete data and fiber wiring system. This system shall include but not limited to patch panels, punch down blocks and terminators, plenum rated wiring of category specified, cable jacks, plates, labels, Autocad drawings that include corresponding device outlet designations for each and every outlet, complete test meeting IEEE TIA 568b standards for each device/wire after completion of installation, etc. All wiring to be installed and supported independent of all other support systems in a neat and organized fashion. Wiring shall be routed so there is separation from all electrical devices, fixtures, electrical power wiring, etc.

1.2. STANDARDS

- A. Conformance to the latest revision of the following is required under this specification.
1. FCC Part 15 - Radio Frequency Devices and Radiation Limits
 2. FCC Part 68 - Connection of Terminal Equipment to the Telephone Network
 3. NEC
 4. National, state, and local building and fire codes.
 5. TIA/EIA 568 - Commercial Building Telecommunications Cabling Standard
 6. TIA/EIA 569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
 7. TIA/EIA 606 - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
 8. UL

1.3. GENERAL REQUIREMENTS

- A. The cable plant to support the data requirements will be wired in a star topology. Provide network attachment points (NAPS) at locations shown on the drawings.
- B. Provide new telecommunication backboards where shown on drawings. Provide on this backboard the appropriate number of termination/connection blocks, having the appropriate capacities, as required for all telephone cables being connected as part of this project, plus 25% "future" telephone cables, and make all required connections. Provide all required cross connections.
- C. Provide data patch panels to the building; make thereon all connections required for the data cables being provided as part of the project, utilizing connections hardware which is appropriate for the respective applications.

- D. Provide telephone outlets where shown on the drawings. Each telephone outlet shall consist of an outlet box recessed to the full extent practicable.
- E. Provide data outlets where shown on the drawings. Each computer outlet shall consist of an outlet box recessed to the full extent practicable.
- F. Provide a combination telephone/data outlet where shown on the drawings. Each combination shall consist of an outlet box recessed to the full extent practicable.
- G. Provide a 3/4" EMT conduit, from each telephone outlet and each data outlet into the drop ceiling or to equipment room backboard, unless shown on the drawings otherwise. Provide a cable from each telephone station outlet and data outlet, through the respecting conduit to the appropriate telecommunication equipment room backboard or patch panel located in the building. Make the proper cable termination/connection at each end of the each such cable utilizing the connecting hardware which is appropriate for the respective applications.
- H. Completely test and prove all data cables, all telephone cables, all terminations/connections, all equipment, and all devices, before and after installation and connection, to the architect's and the owner's complete satisfaction, and as required for the proper operation.

PART 2 - PRODUCTS

2.1. CABLE & EQUIPMENT

- A. Subject to compliance with requirements, provide products of one of the following or approved equal:
 - 1. Amp
 - 2. Mohawk
 - 3. Berk-Tek
 - 4. Belden
- B. Horizontal, unshielded twisted pair (UTP), 8 wire data grade TIA/EIA CAT 6 rated cable, non-plenum rated, will be used for the data and telephone requirements. The CAT 6 UTP cable must meet the following requirements:
 - 1. Provide cable suitable for indoor installation.
 - 2. Provide cable with 4 twisted pairs of insulated copper conductors per cable, 24 AWG solid copper, fully insulated with retardant low-smoke thermoplastic material, plenum NEC CMP rated, and UL listed as such.
 - 3. Color code twisted pairs individually, within color coded bundles, to industry standards (ANSI/ICEA Publications 80-576, and EIA-230).
- C. The data cable will be terminated on RJ45 TIA/EIA CAT 6 modular patch panels with a 110 termination that will be mounted in a 2 post rack to be bolt mounted to the floor by the contractor in designated area. All data cabling terminating in the rack will have a service loop of no less than 8 feet located above the ceiling where it enters the room. All data cabling will be installed IAW with TIA/EIA-568b "Commercial Building Standard for Telecommunications Pathways and

Spaces". Telephone cabling will be installed per telephone industry standard TIA/EIA 568-b.2-1.

- D. Terminate all data and telephone drops. Modular wall plates and surface blocks shall be used to terminate the data cable and in the patch panels inside the rack. Rj45 TIA/EIA CAT 6 connectors shall be used for the data drops. All telephone cabling shall be terminated in RJ45 jacks and wall plates or surface blocks at outlets and on wall mounted punch down blocks.
- E. The telephone pair shall be terminated at the correct insert pair for a telephone application.
- F. Label all drops on both ends indicating where the other end of the cable terminates (patch panel, wall plate, etc.) face plates should meet the following requirements:
 - 1. Single gang with 4-port faceplate
- G. Provide a continuous single cable, homogeneous in nature for every cable run. Splices are not permitted. Space as defined by the local building code. The cable shall be installed in a workmanlike manner and comply with standard TIA/EIA CAT 6 system requirements, and all local, state and national codes. Floor penetrations and conduit sleeves should allow 25% extra room for future cabling requirements.
- H. Modular steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - 1. Wall-mounting: aluminum, hinged wall bracket with provisions for power strip mounting.
 - 2. Floor-mounting: steel, freestanding, modular, with vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug.

2.2. HORIZONTAL CABLING PATCH PANELS

- A. Subject to compliance with requirements, provide products of one of the following or approved equal:
 - 1. Leviton
 - 2. Ortronics
 - 3. Nordx
- B. One-piece steel construction, modular or punch-down type, suitable for rack mounting, with factory-applied black baked enamel finish, with device, junction fittings and other matching accessories as required for a complete category 6 system and per UL 5.
- C. Support station cables exiting the telecommunications room every 5-feet on-center using j-hook cable hangers in call accessible ceilings.

- D. Do not exceed 300-feet in length from the termination at the user's faceplate to the termination at the telecommunications rooms.
- E. Provide a minimum of 6 inches of slack sheathed cable behind each station outlet faceplate. Coil slack cable inside the junction box or raceway as per the cabling manufacturer's installation standards.
- F. Route cables a minimum of 6 inches away from power sources to reduce interference from EMI.
- G. Install cables with sufficient bending radius so as not to break or kink, shear or damage binders, or to interfere with transmission in any way.
- H. Neatly dress and organize cables in the accessible ceiling sequentially into groups of 12. Wrap every 24 inches with velcro cable ties as required. Do not tightly bundle cables together.
- I. Route cable homeruns, parallel and perpendicular to building structure allowing for bending radius, and along corridors for ease of access. Do not route cables through an adjacent space if a corridor borders at least one wall of the room.
- J. Provide permanent machine generated labels on each end of the cable no more than 4 inches from the edge of the cable jacket.
- K. Terminate cables with category 6 modular connectors and T568-a pin-pair assignment.
- L. Test cables to TIA/EIA 568 performance standard for the appropriate cable type. Reterminate or replace any cables that do not meet the performance standard.

2.3. LIGHTNING PROTECTOR (BUILDING ENTRANCE TERMINAL)

- A. Provide Circa 1880ENA1/NSC-200 Universal Pair Protector or approved equal that meets UL497
- B. 14" by 20" inch wall mount
- C. Internal fuse link with external two position ground lug
- D. Stackable to allow for future service expansion
- E. No cover required.

2.4. 66 TERMINAL BLOCK

- A. Provide Circa 2650QC/QC or Circa 26100 QC/QC or approved equal

- B. 14.15" by 10.75" or 15" by 11" wall mount
 - C. Stackable to allow for future service expansion
 - D. No cover required
- 2.5. FIBER BREAKOUT BOX
- A. Provide a LANscape Solutions Product, WCH series or equivalent.
- 2.6. RACK MOUNT LIU
- A. Provide a LANscape Solutions Product, CCH series or equivalent.
- 2.7. FIBER SWITCH
- A. Provide a Cisco Catalyst, 6500 series or equivalent.
- 2.8. LABELS
- A. Provide self-laminating adhesive labels, machine printable with a laser printer suitable for cable diameters installed.
 - B. Printable area: 2-inches by 1/2-inch
 - C. Color: white
- 2.9. CONNECTORS
- A. Fiber - Backbone cabling multimode fiber optic connectors types as determined by the data switch manufacturer.
 - B. Copper - Category 6, 8-pin modular connectors, T568-a wired.
 - C. Provide station outlets with connectors. Provide permanent machine generated clear laminated labels on the front of each faceplate or surface box.
- 2.6. Provide J-hooks rated to support category 6 cable and optical fiber cable, mounted 5-foot on-center for support of horizontal cabling. Do not exceed 40 percent fill ratio. Provide J-hooks with galvanized steel construction and 90 degree rolled safety edges. Provide latched retainers to contain cables within the hook area. Provide J-hooks with a static load capacity of 30 pounds per hook and fastener hole that accepts 1/4-inch bolts.
- 2.7. INNERDUCT AND ACCESSORIES:
- A. 1-1/2-inch nominal inner diameter

- B. Provide corrugated innerduct with a polyethylene pull rope (minimum pull tensions rating of 1,200 lb) pre-installed for the installation of cable.
- C. Provide each innerduct continuous and uniquely colored for identification.

2.8. Velcro Cable Ties: 3/4-inch wide with a minimum 2 inch overlap.

PART 3 - PROJECT CLOSE OUT

3.1. Submit as-built drawings to contracting officer's representative prior to final acceptance of system:

- A. Scaled floor plans of telecommunication rooms showing exact placement of LAN racks and termination hardware.
- B. Scaled floor & overhead plans of telecommunication rooms showing exact placement of all overhead cable support routes.
- C. Installation details.
- D. Provide data disks of each of the final as-built drawings prepared using Autocad software, fully representing actual installed conditions.

3.2. INSPECTION

- A. After project completion at a date and time specified by the contracting officer, the government will conduct an inspection visit of the completed site. The contractor shall attend that inspection visit and be prepared to effect corrections if deficiencies are found.
- B. Test results
 - 1. Provide one electronic copy and one printed copy of cable test results documentation appropriately formatted for retrieval by the contracting officer.
 - 2. Provide the Architect and Owner with a written form of acceptance for signature. All corrections must be completed before acceptance is given.

END OF SECTION