Division 16 - Electrical Specifications

16010 General Provisions 16015 Record Drawings & Documents 16020 Work Definitions 16030 Codes & Standards 16040 Temporary Power & Lighting 16050 Basic Materials and Methods 16055 Coordination Study 16060 Grounding & Bonding 16072 Supports & Seismic Restraints 16075 Identification 16120 Conductors & Cables 16130 Raceways & Boxes 16139 Cable Trays 16140 Wiring Devices 16145 Lighting Controls 16231 Packaged Engine Generator 16289 Transient Voltage Suppression 16400 Main Electrical Service 16410 Enclosed Switches & Circuit Breakers 16415 Transfer Switches 16441 Switchboards 16442 Panelboards 16491 Fuses 16511 Interior Lighting 16521 Exterior Lighting 16721 Fire Alarm 16753 Data Raceway System 16760 Audio Visual Telecommunications Systems 16765 Television Distribution Systems 16780 Background Music / Music on Hold System 16781 Television Accessories 16785 Closed Circuit Television System 16786 Meeting Room Systems 16787 Internet Access 16790 Terminations

GENERAL PROVISIONS

PART 1 GENERAL

1.1 GOVERNING CLAUSE

A. These specifications will omit phrases such as "Contractor shall furnish and install", "unless otherwise indicated or specified", etc. for the sake of brevity, but these phrases are nevertheless implied. The Contractor is required to furnish and install materials, perform all operations, and complete the project to the satisfaction of the Architect.

1.2 GENERAL CONDITIONS

- A. The Architect's General, Special, and Supplementary Conditions for the construction of this project shall be a part of the Electrical Specifications. The Electrical Contractor shall examine the general, special, and supplementary conditions before submitting his or her proposal.
- B. The General Contractor shall be responsible for all work included in this section and the delegation of work to the Electrical Contractor shall not relieve him of this responsibility. The Electrical Contractor and his subcontractors who perform work under this section shall be responsible to the General Contractor.
- C. Where items of the General Conditions or of the Special Conditions are repeated in this section of the specifications, it is intended to call particular attention to or qualify them. It is not intended that any other parts of the General Conditions or Special Conditions shall be assumed to be omitted if not repeated herein.
- D. The naming of a certain brand or make or manufacturer in the specifications is to establish a quality standard for the article desired. The Contractor is not restricted to the use of the specified brand of the manufacturer named unless so indicated in the specifications. However, where a substitution is requested, a substitution will be permitted only with the written approval of the Engineer. No substitute material or equipment shall be ordered, fabricated, shipped or processed in any manner prior to the approval of the Architect/Engineer. The Contractor shall assume all responsibility for additional expenses as required in any way to meet changes from the original material or equipment specified. If notice of substitution is not furnished to the Engineer within 15 days after the General Contract is awarded, then equipment and materials named in the specifications are to be used.

- E. The Electrical Contractor shall examine drawings relating to work of all trades and become fully informed as to extent and character of work required and its relation to all other work in the project.
- F. Before submitting bid, Contractor shall visit the site and examine all adjoining existing buildings, equipment, and space conditions on which his or her work is in any way dependent for the best workmanship and operation according to the intent of specifications and drawings. He or she shall report to the Architect any condition, which might prevent him or her from installing his or her equipment in the manner intended.
- G. No consideration or allowance will be granted for failure to visit site, or for any alleged misunderstanding of materials to be furnished or work to be done.
- H. Contractor to contact and coordinate with all local utility companies for construction and service requirements of all utilities.
- I. Contractor shall secure and pay for all assessments, permits, electric utility companies' fees and charges, and inspections required on work performed under this section of the specifications and contract

RECORD DRAWINGS AND DOCUMENTS

PART 1 CONTRACT DOCUMENTS

1.1 DRAWINGS

- A. The Drawings are diagrammatic and indicate generally the locations of the material and equipment. These Drawings shall be followed as closely as possible. The Electrical Contractor shall coordinate the work under this section with the architectural, structural, plumbing, heating and air conditioning, and the drawings of other trades for exact dimensions, clearances and rough-in locations. The Contractor shall cooperate with all other trades in order to make minor field adjustments to accommodate the work of others.
- B. The Drawings and Specifications are complementary, each to the other, and the work required by either should be included in the Contract as if called for by both.
- C. If directed by the Architect, the Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

1.2 SYMBOLS

A. Electrical symbols used on this project are shown in a Symbol Legend on the accompanying working drawings. This list shows standard symbols and all may not appear on the project drawings; however, wherever the symbol on the project drawings occurs, the item shall be provided and installed

PART 2 SUBMITTALS

2.1 INSTRUCTIONS

- A. The Electrical Contractor shall furnish and present 10 (10) copies of shop drawings and/or brochures for all fixtures, equipment, and accessories to the Engineer/Architect for the Engineer's approval.
- B. No equipment shall be ordered, purchased or installed prior to approval of the shop drawings, brochures and schedules. Checking is only for general conformance with the design concept of the project and general compliance is subject to the requirements of the plans and specifications. Contractor is responsible for:
 - Dimensions which shall be confirmed and correlated at the job site;

- 2. Fabrication processes and techniques of construction;
- 3. Coordination of his or her work with that of all other trades and the satisfactory performance of his or her work.
- C. If the submittals are rejected, the contractor will be allowed to resubmit on the rejected materials two (2) additional times. If the submittal for any material is rejected three times, then the originally specified piece of equipment shall be supplied at no extra cost.
- PART 3 CLOSEOUT DOCUMENTS

3.1 INSTRUCTIONS

- A. The contractor shall furnish to the Architect at job acceptance the following:
 - Two sets of black line prints of same scale as original drawings marked in red showing all variations of the work actually installed related to the original drawings. This set of drawings shall include all of the following:
 - a. Addenda
 - b. Approved and Installed Change Orders
 - c. Field Condition Changes
 - d. All other Departures from the Original Plans and Specifications
 - Three sets of shop drawings and other data required by the specifications reflecting the manufacturer's shop fabrication of the materials actually installed. These sets of data shall be post bound, indexed, and tabbed.
 - Operation and Maintenance manuals and manufacturer's instructions for all equipment and components supplied and/or installed by the Electrical Contractor

WORK DEFINITIONS

PART 1 WORK INCLUDED

1.1 INSTRUCTIONS

- A. The scope of work consists of the furnishing and installing of complete systems - exterior and interior - including miscellaneous systems. The Electrical Contractor shall provide all supervision, labor, materials, equipment, machinery, and any and all other items necessary to complete the system.
- B. It is the intention of the Specifications and Drawings to call for finished work, tested, and ready for operation.
- C. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified, shall be furnished, delivered and installed by the Contractor without additional expense to the Owner.
- D. Minor details not usually shown or specified, but necessary for proper installation and operation, shall be included in the Contractor's estimate, the same as if herein specified or shown.
- E. With submission of bid, the Electrical Contractor shall give written notice to the Architect of any materials or apparatus believed inadequate or unsuitable, in violation of laws, ordinances, rules; any necessary item work omitted. In the absence of such written notice, it is mutually agreed the Contractor has included the cost of all required items in his or her proposal, and that he or she will be responsible for the approved satisfactory functioning of the entire system without extra compensation.

1.2 DEMOLITION

- A. Demolition of existing equipment noted or required by the new work shall consist of removal of equipment, removal of exposed conduit, removal of wiring back to next in line junction or over-current protection device, and reconnection or rerouting of feed-through circuits. All equipment removed shall remain property of the Owner unless the Contractor is otherwise instructed in which case it shall be removed from the site.
- B. Remove, store, clean, reinstall, reconnect, and make operational components and equipment indicated for relocation.
- C. Disposal of materials removed from the job deemed hazardous shall be disposed of in compliance with the Resource Conservation

Recovery Act (RCRA) Subtitle C. These types of material include, but are not exclusively limited to, the following:

- 1. Fluorescent Lamps
- 2. Compact Fluorescent Lamps
- 3. H. I. D. Lamps
- 4. Electrical Power Transformers containing PCB's

PART 2 WORK NOT INCLUDED

2.1 INSTRUCTIONS

- A. The following equipment items and work shall be the responsibility of others:
 - 1. Motors and controls, unless indicated otherwise, shall be furnished by others, but shall be installed and connected by the Electrical Contractor as indicated on the drawings.
 - 2. Elevator signal and control wiring beyond service feeder noted on drawings shall be provided and installed by others. (If Applicable)
 - 3. Controls for motors on mechanical equipment unless otherwise indicated, will be furnished by others, but shall be installed and connected by the Electrical Contractor.

CODES & STANDARDS

PART 1 GENERAL

1.1 INSTRUCTIONS

- A. All materials and workmanship shall comply with all applicable codes, specifications, local ordinances, industry standards, and utility company and fire insurance carrier's requirements.
- B. In case of difference between the building codes, specifications, state laws, local ordinances, industry standards, utility company regulations, fire insurance carrier's requirements, and the contract documents, the most stringent shall govern. The Contractor shall promptly notify the Architect in writing of any difference.
- C. Noncompliance: Should the Contractor perform any work that does not comply with the requirements of the applicable building codes, state laws, local ordinances, industry standards, fire insurance carrier's requirements, and utility company regulations, he or she shall bear the cost arising in correcting any such deficiency.
- D. Applicable codes and all standards shall include all state laws, local ordinances, utility company regulations, and the applicable requirements of the following nationally accepted codes and standards:
 - 1. Building Codes
 - a. International Building Code
 - b. Local Building Code
 - c. National Electrical Code
 - d. State Electrical Code
 - e. Local Municipal Electrical Code
 - 2. Industry Standards, Codes and Specifications
 - a. ANSI American National Standard Institute
 - b. AMCA Air Moving and Conditioning Association
 - c. ASHRAE American Society of Heating, Refrigeration, and Air Conditioning Engineers

- d. ASME American Society of Mechanical Engineers
- e. ASTM American Society for Testing and Materials
- f. EIA Electronic Industries Association
- g. ICEA Insulated Cable Engineers' Association
- h. IEEE Institute of Electrical and Electronic Engineers
- i. IPCEA Insulated Power Cable Engineers' Association
- j. NBS National Bureau of Standards
- k. NEC National Electrical Code (NFPA-70 1999)
- 1. NESC National Electrical Safety Code (ANSI C2)
- m. NEMA National Electrical Manufacturers' Association
- n. NFPA National Fire Protection Association
- o. OSHA Occupational Safety and Health Administration
- p. SBC Standard Building Code
- q. UL Underwriters' Laboratories
- r. USASI United States of America Standards Institute
- s. USEPA United States Environmental Protection Agency
- 3. Insurance Carriers
 - a. FIA Factory Insurance Association
 - b. FMED Factory Mutual Engineering Division

TEMPORARY POWER AND LIGHTING

PART 1 EXECUTION

1.1 GENERAL

A. Any light or power outlets required over the maximum quantity noted below shall be paid for by the Contractor requiring the same. The General Contractor shall pay for the power consumption.

1.2 TEMPORARY POWER

- A. The Electrical Contractor shall be responsible for all arrangements and cost for providing temporary electrical metering, main switches, and distribution panels at the site as required for construction purposes. The distribution panels shall be located at a central point designated by the Architect. The General Contractor shall indicate prior to installation whether three-phase or single-phase service is required.
- B. The Electrical Contractor shall furnish and install power outlets to total one for every 1500 square feet or part thereof of floor area and these shall be GFI, 20-amp, single-phase receptacles for either 110 or 220 volts as directed by the General Contractor.

1.3 TEMPORARY LIGHTING

A. The Electrical Contractor shall furnish and install one OSHA approved pigtail socket with 150-watt lamp for every 500 square feet of floor space, evenly distributed throughout the building.

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Common electrical installation requirements.

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE

A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

1.6 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

- 3. To allow right of way for piping and conduit installed at required slope.
- 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."
- D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.138-inch (3.5-mm) thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.3 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.
- PART 3 EXECUTION
- 3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION
 - A. Comply with NECA 1.
 - B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
 - C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
 - D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
 - E. Right of Way: Give to raceways and piping systems installed at a required slope.
- 3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS
 - A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
 - B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

- C. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- D. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- E. Rectangular Sleeve Minimum Metal Thickness:
 - For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).
- F. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- G. Cut sleeves to length for mounting flush with both surfaces of walls.
- H. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- I. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require a different clearance.
- J. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- K. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- L. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with Division 7 Section "Through-Penetration Firestop Systems."
- M. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- N. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- O. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular

clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."
- 3.5 FIELD QUALITY CONTROL
 - A. Inspect installed sleeve and sleeve-seal installations and associated firestopping for damage and faulty work.

OVERCURRENT PROTECTIVE DEVICE COORDINATION

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 computer-based, fault-current and overcurrent protective device coordination studies, and the setting of these devices.
 - 1. Coordination of series-rated devices is permitted where indicated on Drawings.

1.3 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.
- D. Other Action Submittals:
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Coordination-study report.
 - 3. Equipment evaluation report.
 - 4. Setting report.

1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

- C. Testing Agency Qualifications: Member company of the InterNational Electrical Testing Association.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise testing specified in Part 3.
- D. Comply with IEEE 399 for general study procedures.
- E. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- PART 2 PRODUCTS
- 2.1 COMPUTER SOFTWARE DEVELOPERS
 - A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
 - 1. CYME International, Inc.
 - 2. EDSA Micro Corporation.
 - 3. Electrical Systems Analysis, Inc.
 - 4. SKM Systems Analysis, Inc.
- 2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS
 - A. Comply with IEEE 399.
 - B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.
 - C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.
 - 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
- B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

3.2 FAULT-CURRENT AND ARC-FAULT STUDIES

- A. Source Impedance: As an infinite bus on primary side of utility transformer.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculate available Arc Fault current for each panel and identify level of protection required in relation to this calculation.
- E. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:
 - 1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
 - 2. Low-Voltage Fuses: IEEE C37.46.
 - 3. Circuit Breakers: IEEE C37.13.
- F. Study Report: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle faultcurrent values for 3-phase, 2-phase, and phase-to-ground faults.
- G. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing faultcurrent ratings of these devices with calculated fault-current momentary and interrupting duties.

3.3 COORDINATION STUDY

A. Gather and tabulate the following input data to support coordination study:

- 1. Product Data for overcurrent protective devices specified in other Division 16 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
- 2. Impedance of utility service entrance.
- 3. Electrical distribution system diagram showing the following:
 - a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
 - b. Circuit-breaker and fuse-current ratings and types.
 - c. Relays and associated power and current transformer ratings and ratios.
 - d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - e. Generator kilovolt amperes, size, voltage, and source impedance.
 - f. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
 - g. Busway ampacity and impedance.
 - h. Motor horsepower and code letter designation according to NEMA MG 1.
- 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Magnetic inrush current overload capabilities of transformers.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Ratings, types, and settings of utility company's overcurrent protective devices.
 - e. Special overcurrent protective device settings or types stipulated by utility company.
 - f. Time-current-characteristic curves of devices indicated to be coordinated.
 - g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - h. Manufacturer and type, ampere-tap adjustment range, timedelay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - i. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.
- B. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.
- C. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

- D. Comply with IEEE 242 recommendations for fault currents and time intervals.
- E. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Self-cooled, full-load current or forced-air-cooled, fullload current, whichever is specified for that transformer.
 - b. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.
- F. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- G. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.
- H. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 - 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
 - 3. Completed data sheets for setting of overcurrent protective devices.

3.4 OVERCURRENT PROTECTIVE DEVICE SETTING

- A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to set the overcurrent protective devices within equipment.
- B. Testing: Perform the following device setting and prepare reports:
 - After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:
 - a. Verify that overcurrent protective devices meet parameters used in studies.
 - b. Adjust devices to values listed in study results.
 - Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 10.7 and 10.8 in NETA ATS.

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications (when applicable):
 - 1. Overhead-lines grounding.
 - 2. Underground distribution grounding.
 - 3. Common ground bonding with lightning protection system.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings and grids.
 - 4. Grounding arrangements and connections for separately derived systems.
 - 5. Grounding for sensitive electronic equipment.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
 - 1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NFPA 70B.
 - a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
 - b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise onsite testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
 - 1. No. 4 AWG minimum, soft-drawn copper.
 - 2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.
- D. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in

which used, and for specific types, sizes, and combinations of conductors and other items connected.

- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.
- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or Lshaped, charged with non-hazardous electrolytic chemical salts. These may only be used when specifically called for on the plans.
 - 1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
 - 2. Backfill Material: Electrode manufacturer's recommended material.
- PART 3 EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches (600 mm) below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in all electrical and telephone/data equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.

- 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Grid: Exothermic Welded connectors.
 - 4. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 5. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING OVERHEAD LINES

- A. Comply with IEEE C2 grounding requirements.
- B. Install 3 parallel ground rods if resistance to ground by a single, ground-rod electrode exceeds 25 ohms.
- C. Drive ground rods until tops are 12 inches (300 mm) below finished grade in undisturbed earth.
- D. Ground-Rod Connections: Install bolted connectors for underground connections and connections to rods.
- E. Lightning Arrester Grounding Conductors: Separate from other grounding conductors.
- F. Secondary Neutral and Transformer Enclosure: Interconnect and connect to grounding conductor.
- G. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communication service and transformer spaces.

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, harddrawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.4 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor

terminal of the applicable derived system or service, unless otherwise indicated.

- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50by-300-mm) grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- H. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branchcircuit conductors.

3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 2 Section "Underground Ducts and Utility Structures," and shall be at least 12 inches (300 mm) deep, with cover.
 - 1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
- I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column and indicated item (if shown on drawings), extending around the perimeter of building or area or item indicated (if shown on drawings).
 - 1. Install tinned-copper conductor not less than No. 3/0 AWG for ground ring and for taps to building steel.

2. Bury ground ring not less than 24 inches (600 mm) from building foundation.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 - 3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
 - 2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
 - 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 - 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm.
 - 5. Substations and Pad-Mounted Equipment: 5 ohms.
 - 6. Manhole Grounds: 10 ohms.
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect and Engineer promptly and include recommendations to reduce ground resistance.

ELECTRICAL SUPPORTS AND SEISMIC RESTRAINTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Seismic restraints for electrical equipment and systems.
 - 3. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IBC: International Building Code.
- C. IMC: Intermediate metal conduit.
- D. NBC: National Building Code.
- E. OSHPD: Office of Statewide Health Planning and Development.
- F. RMC: Rigid metal conduit.
- G. SBC: Standard Building Code.
- H. Seismic Restraint: A structural support element such as a metal framing member, a cable, an anchor bolt or stud, a fastening device, or an assembly of these items used to transmit seismic forces from an item of equipment or system to building structure and to limit movement of item during a seismic event.
- I. UBC: Uniform Building Code.

1.4 SUBMITTALS

A. Product Data: Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of electrical support and seismic-restraint component used.

- 1. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
- 2. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Shop Drawings: Indicate materials and dimensions and identify hardware, including attachment and anchorage devices, signed and sealed by a qualified professional engineer. Professional engineer qualification requirements are specified in Division 1 Section "Quality Requirements." Include the following:
 - 1. Fabricated Supports: Representations of field-fabricated supports not detailed on Drawings.
 - 2. Seismic Restraints: Detail anchorage and bracing not defined by details or charts on Drawings. Include the following:
 - Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Detail fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
 - c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction], showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- D. Welding certificates.
- E. Qualification Data: For professional engineer and testing agency.
- F. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Testing of Seismic Anchorage Devices: Comply with testing requirements in Part 3 and in Division 16 Section "Electrical Supports and Seismic Restraints."
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."

1.6 PROJECT CONDITIONS

A. Site Class as Defined by the Architect. Refer to architectural documents for classification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- 2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS
 - A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed under this Project, with a minimum structural safety factor of five times the applied force.
 - B. Steel Slotted Support Systems: Comply with MFMA-3, factory-fabricated components for field assembly.
 - 1. Manufacturers:
 - a. Cooper B-Line; a division of Cooper Industries.
 - b. ERICO International Corporation.
 - c. Allied Support Systems; Power-Strut Unit.
 - d. GS Metals Corp.
 - e. Michigan Hanger Co., Inc.; O-Strut Div.
 - f. National Pipe Hanger Corp.
 - g. Thomas & Betts Corporation.
 - h. Unistrut; Tyco International, Ltd.
 - i. Wesanco, Inc.
 - 2. Finishes:
 - a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-3.
 - b. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-3.
 - c. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-3.
 - 3. Channel Dimensions: Selected for structural loading and applicable seismic forces.

- C. Nonmetallic Slotted Support Systems: Structural-grade, factoryformed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
 - 1. Manufacturers:
 - a. Allied Support Systems; Aickinstrut Unit.
 - b. Cooper B-Line; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 - 2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 - 3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 - 4. Rated Strength: Selected to suit structural loading and applicable seismic forces.
- D. Raceway and Cable Supports: As described in NECA 1.
- E. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers:
 - 1) Hilti, Inc.
 - 2) ITW Construction Products.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co. Inc.
 - Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

- a. Manufacturers:
 - 1) Cooper B-Line; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc
 - 3) Hilti, Inc.
 - 4) ITW Construction Products.
 - 5) MKT Fastening, LLC.
 - 6) Powers Fasteners.
- 3. Concrete Inserts: Steel or malleable-iron slotted-support-system units similar to MSS Type 18; complying with MFMA-3 or MSS SP-58.
- 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
- 5. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
- 6. Toggle Bolts: All-steel springhead type.
- 7. Hanger Rods: Threaded steel.

2.3 SEISMIC-RESTRAINT COMPONENTS

- A. Rated Strength, Features, and Application Requirements for Restraint Components: As defined in reports by an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Strength in tension, shear, and pullout force of components used shall be at least five times the maximum seismic forces to which they will be subjected.
- B. Angle and Channel-Type Brace Assemblies: Steel angles or steel slotted-support-system components; with accessories for attachment to braced component at one end and to building structure at the other end.
- C. Cable Restraints: ASTM A 603, zinc-coated, steel wire rope attached to steel or stainless-steel thimbles, brackets, swivels, and bolts designed for restraining cable service.
 - 1. Manufacturers:
 - a. Amber/Booth Company, Inc.
 - b. Loos & Co., Inc.
 - c. Mason Industries, Inc.
 - Seismic Mountings, Anchors, and Attachments: Devices as specified in Part 2 "Support, Anchorage, and Attachment Components" Article, selected to resist seismic forces.
 - 3. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod, of design recognized by an agency acceptable to authorities having jurisdiction.
 - 4. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to type and size of anchor bolts and studs used.
 - 5. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for

seismically rated rigid equipment mountings, and matched to type and size of attachment devices used.

- 2.4 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES
 - A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
 - B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.
- PART 3 EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 for application of hangers and supports for electrical equipment and systems, except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel or by method approved by authority having jurisdiction.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT AND SEISMIC-RESTRAINT INSTALLATION

- A. Comply with NECA 1 for installation requirements, except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Install seismic-restraint components using methods approved by the evaluation service providing required submittals for component.

- D. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and seismic criteria at Project.
- B. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so
expansion anchors will be a minimum of 10 bolt diameters from edge of the base.

- Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450mm) centers around full perimeter of the base.
- 2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
- 3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- 5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- 6. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."

3.5 INSTALLATION OF SEISMIC-RESTRAINT COMPONENTS

- A. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Restraint Cables: Provide slack within maximums recommended by manufacturer.
- D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

3.6 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Make flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross expansion and seismic-control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to electrical equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing: Test pullout resistance of seismic anchorage devices.

- 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
- 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
- 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
- 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
- 5. Test to 90 percent of rated proof load of device.
- 6. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- C. Record test results.

END OF SECTION 16072

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Identification for raceway and metal-clad cable.
 - 2. Identification for conductors and communication and control cable.
 - 3. Underground-line warning tape.
 - 4. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

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

PART 2 - PRODUCTS

- 2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS
 - A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 - B. Color for Printed Legend:
 - 1. Power Circuits: Black letters on an orange field.
 - 2. Legend: Indicate system or service and voltage, if applicable.
 - C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
 - D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, colorcoded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
 - E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solidcolored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
 - F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.
- 2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS
 - A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.35-mm-) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.

2.3 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressuresensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING OSHA REGULATION AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.5 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and ultraviolet-resistant seal for label.
- C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength: 50 lb (22.6 kg), minimum.
 - Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Black, except where used for color-coding.
- B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.
 - 1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Exterior concrete and masonry primer.

- 2) Finish Coats: Exterior semigloss acrylic enamel.
- 2. Exterior Concrete Unit Masonry:
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
 - 1) Block Filler: Concrete unit masonry block filler.
 - 2) Finish Coats: Exterior semigloss acrylic enamel.
- 3. Exterior Ferrous Metal:
 - a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Exterior ferrous-metal primer.
 - 2) Finish Coats: Exterior semigloss alkyd enamel.
- 4. Exterior Zinc-Coated Metal (except Raceways):
 - a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a
 primer.
 - 1) Primer: Exterior zinc-coated metal primer.
 - 2) Finish Coats: Exterior semigloss alkyd enamel.
- 5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):
 - a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior concrete and masonry primer.
 - 2) Finish Coats: Interior semigloss alkyd enamel.
- 6. Interior Concrete Unit Masonry:
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
 - 1) Block Filler: Concrete unit masonry block filler.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
- 7. Interior Gypsum Board:
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior gypsum board primer.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
- 8. Interior Ferrous Metal:
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.

- 1) Primer: Interior ferrous-metal primer.
- 2) Finish Coats: Interior semigloss acrylic enamel.
- 9. Interior Zinc-Coated Metal (except Raceways):
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior zinc-coated metal primer.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
- C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:
 - Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
 - 2. Wall surfaces directly external to raceways concealed within wall.
 - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- B. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches (50 mm) high, with snap-around labels. Repeat legend at 10-foot (3-m) maximum intervals.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange self-adhesive vinyl tape applied in bands.
- D. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
 - 1. Fire Alarm System: Red.
 - 2. Fire-Suppression Supervisory and Control System: Red and yellow.
 - 3. Combined Fire Alarm and Security System: Red and blue.
 - 4. Security System: Blue and yellow.
 - 5. Mechanical and Electrical Supervisory System: Green and blue.
 - 6. Telecommunication System: Green and yellow.

- 7. Control Wiring: Green and red.
- E. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- F. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.
- G. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source and circuit number.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
 - Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
 - 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- K. Instruction Signs:
 - 1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved

legend where instructions are needed for system or equipment operation.

- Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer and load shedding (if applicable).
- L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - 2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Electrical switchgear and switchboards.
 - d. Transformers.
 - e. Emergency system boxes and enclosures.
 - f. Motor-control centers.
 - g. Disconnect switches.
 - h. Enclosed circuit breakers.
 - i. Motor starters.
 - j. Push-button stations.
 - k. Power transfer equipment.
 - 1. Contactors.
 - m. Remote-controlled switches, dimmer modules, and control devices.
 - n. Power-generating units.
 - o. Voice and data cable terminal equipment.
 - p. Intercommunication and call system master and staff stations.
 - q. Television/audio components, racks, and controls.
 - r. Fire-alarm control panel and annunciators.
 - s. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
 - t. Monitoring and control equipment.
 - u. Uninterruptible power supply equipment.
 - v. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Colors for 480/277-V Circuits:

a.	Phase	A:	Brown.
b.	Phase	B:	Orange.
c.	Phase	C:	Yellow.

- 4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where

width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

I. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

END OF SECTION 16075

SECTION 16120

CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged by Contractor.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
 - Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
- 2.2 CONDUCTORS AND CABLES
 - A. Manufacturers:
 - 1. Alcan Aluminum Corporation; Alcan Cable Div.
 - 2. American Insulated Wire Corp.; a Leviton Company.
 - 3. General Cable Corporation.
 - 4. Senator Wire & Cable Company.
 - 5. Southwire Company.
 - B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
 - C. Conductor Material: Copper complying with NEMA WC 5; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.
 - D. Conductor Insulation Types: Type THHN-THWN complying with NEMA WC 5 or7.
 - E. Multiconductor Cable: Metal-clad cable, Type MC, Type SO and Type USE with ground wire.

2.3 CONNECTORS AND SPLICES

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc.
 - 2. AMP Incorporated/Tyco International.
 - 3. Hubbell/Anderson.
 - 4. O-Z/Gedney; EGS Electrical Group LLC.
 - 5. 3M Company; Electrical Products Division.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway.
- B. Feeders Exposed or Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspaces: Type THHN-THWN, single conductors in raceway.
- D. Branch Circuits Exposed or Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway or type MC cable (for 120V 20A circuits only).
- E. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
- F. Underground Feeders and Branch Circuits: Type THHN-THWN, single conductors in raceway.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.
- H. Fire Alarm Circuits: Type THHN-THWN or TFFN, in raceway.
- I. Class 1 Control Circuits: Type THHN-THWN or TFFN, in raceway.
- J. Class 2 Control Circuits: Type THHN-THWN or TFFN, in raceway.

3.2 INSTALLATION

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 16 Section "Basic Electrical Materials and Methods."
- F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."

G. Identify and color-code conductors and cables according to Division 16 Section "Electrical Identification."

3.3 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.
- 3.4 FIELD QUALITY CONTROL
 - A. Testing: Perform the following field quality-control testing:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
 - B. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 16120

SECTION 16130

RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 2 Section "Underground Ducts and Utility Structures" for exterior ductbanks, manholes, and underground utility construction.
 - 2. Division 7 Section "Through-Penetration Firestop Systems" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
 - 3. Division 16 Section "Electrical Supports and Seismic Restraints" for seismic restraints and bracing of raceways, boxes, enclosures, and cabinets.
 - 4. Division 16 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. FMC: Flexible metal conduit.
- D. IMC: Intermediate metal conduit.
- E. LFMC: Liquidtight flexible metal conduit.
- F. LFNC: Liquidtight flexible nonmetallic conduit.
- G. RNC: Rigid nonmetallic conduit.
- H. RMC: Rigid metallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: Show fabrication and installation details of components for raceways, fittings, boxes, enclosures, and cabinets.
- C. Shop Drawings: Signed and sealed by a qualified professional engineer.
 - 1. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 2. Detail assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- E. Manufacturer Seismic Qualification Certification: Submit certification that enclosures, cabinets, accessories, and components will withstand seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY ASSURANCE

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

1.6 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 METAL CONDUIT AND TUBING

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflex Inc.
 - 3. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 4. Electri-Flex Co.
 - 5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
 - 6. LTV Steel Tubular Products Company.
 - 7. Manhattan/CDT/Cole-Flex.
 - 8. O-Z Gedney; Unit of General Signal.
 - 9. Wheatland Tube Co.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Aluminum Rigid Conduit: ANSI C80.5.
- D. IMC: ANSI C80.6.
- E. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.
- F. Plastic-Coated IMC and Fittings: NEMA RN 1.
- G. EMT and Fittings: ANSI C80.3.

1. Fittings: Compression type.

- H. FMC: Zinc-coated steel.
- I. LFMC: Flexible steel conduit with PVC jacket.

- J. Fittings: NEMA FB 1; compatible with conduit and tubing materials.
- 2.3 NONMETALLIC CONDUIT AND TUBING
 - A. Manufacturers:
 - 1. American International.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 3. Arnco Corp.
 - 4. Cantex Inc.
 - 5. Certainteed Corp.; Pipe & Plastics Group.
 - 6. Condux International.
 - 7. ElecSYS, Inc.
 - 8. Electri-Flex Co.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT/Cole-Flex.
 - 11. RACO; Division of Hubbell, Inc.
 - 12. Spiralduct, Inc./AFC Cable Systems, Inc.
 - 13. Thomas & Betts Corporation.
 - B. ENT: NEMA TC 13.
 - C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.
 - D. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.
 - E. LFNC: UL 1660.

2.4 METAL WIREWAYS

- A. Available Manufactuers:
 - 1. Hoffman.
 - 2. Square D.
- B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 3R.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- E. Wireway Covers: Flanged-and-gasketed type or as indicated on the plans.
- F. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS

- A. Available Manufactures:
 - 1. Hoffman.
 - 2. Lamson & Sessions; Carlon Electrical Products.
- B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- E. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- F. All elbows 45 degrees or greater and all vertical risers coming out of the ground or slab shall be RMS or IMC type conduit.

2.6 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating and as directed by the architect.
 - 1. Manufacturers:
 - a. Airey-Thompson Sentinel Lighting; Wiremold Company (The).
 - b. Thomas & Betts Corporation.
 - c. Walker Systems, Inc.; Wiremold Company (The).
 - d. Wiremold Company (The); Electrical Sales Division.
- B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC compound with matte texture and color as directed by the archtect.
 - 1. Manufacturers:
 - a. Butler Manufacturing Co.; Walker Division.
 - b. Enduro Composite Systems.
 - c. Hubbell, Inc.; Wiring Device Division.
 - d. Lamson & Sessions; Carlon Electrical Products.
 - e. Panduit Corp.
 - f. Walker Systems, Inc.; Wiremold Company (The).
 - g. Wiremold Company (The); Electrical Sales Division.

C. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.7 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. Emerson/General Signal; Appleton Electric Company.
 - 3. Erickson Electrical Equipment Co.
 - 4. Hoffman.
 - 5. Hubbell, Inc.; Killark Electric Manufacturing Co.
 - 6. O-Z/Gedney; Unit of General Signal.
 - 7. RACO; Division of Hubbell, Inc.
 - 8. Robroy Industries, Inc.; Enclosure Division.
 - 9. Scott Fetzer Co.; Adalet-PLM Division.
 - 10. Spring City Electrical Manufacturing Co.
 - 11. Thomas & Betts Corporation.
 - 12. Walker Systems, Inc.; Wiremold Company (The).
 - 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
- D. Floor Boxes: Cast metal, fully adjustable, rectangular, 2 or 3 gang type.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic, finished inside with radiofrequency-resistant paint.
- H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.8 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

- 3.1 RACEWAY APPLICATION
 - A. Outdoors:
 - 1. Exposed: Rigid steel or IMC.
 - 2. Concealed: Rigid steel or IMC.
 - 3. Underground, Single Run: RNC.
 - 4. Underground, Grouped: RMC.
 - 5. Underground, 2" or greater: IMC or RMC.
 - 6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 7. Boxes and Enclosures: NEMA 250, Type 3.
 - B. Indoors:
 - 1. Exposed: EMT.
 - 2. Concealed: EMT.
 - 3. Conduits 2" or greater: IMC or RMC.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
 - 5. Damp or Wet Locations: Rigid steel conduit.
 - 6. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.
 - C. Minimum Raceway Size: 1/2-inch trade size (DN 21).
 - D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
 - E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
 - F. Do not install aluminum conduits embedded in or in contact with concrete.

3.2 INSTALLATION

- A. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.

- C. Support raceways as specified in Division 16 Section "Electrical Supports and Seismic Restraints."
- D. Install temporary closures to prevent foreign matter from entering raceways.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
 - 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete.
 - 3. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 4. Change from nonmetallic tubing to rigid steel conduit, or IMC before rising above the floor.
- I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
 - 1. Run parallel or banked raceways together on common supports.
 - 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- J. Join raceways with fittings designed and approved for that purpose and make joints tight.
 - 1. Use insulating bushings to protect conductors.
- K. Tighten set screws of threadless fittings with suitable tools.
- L. Terminations:
 - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection

shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

- M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
- N. Telephone and Signal System Raceways, 2-Inch Trade Size (DN 53) and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
- O. Install raceway sealing fittings at suitable, approved, and 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 points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- P. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- Q. Flexible Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- R. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- S. Set floor boxes level and flush with finished floor surface.
- T. Set floor boxes level. Trim after installation to fit flush with finished floor surface.
- U. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.3 PROTECTION

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

3.4 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 16130

SECTION 16139

CABLE TRAYS

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 aluminum cable trays and accessories.
- B. Related Sections include the following:
 - 1. Division 7 Section "Through-Penetration Firestop Systems" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.

1.3 SUBMITTALS

- A. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
 - Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, spliceplate connectors, expansion-joint assemblies, straight lengths, and fittings.
 - 2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 3. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer.
 - a. Design Calculations: Calculate requirements for selecting seismic restraints.
 - b. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.
- C. Coordination Drawings: Floor plans and sections drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural and mechanical elements. Show the following:

- 1. Vertical and horizontal offsets and transitions.
- 2. Clearances for access above and to side of cable trays.
- 3. Vertical elevation of cable trays above floor or bottom of ceiling structure.
- D. Product Certificates: For each type of cable tray, signed by product manufacturer.
- E. Manufacturer Seismic Qualification Certification: Submit certification that cable trays, accessories, and components will withstand seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Cable Tray Units: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- F. Field Test Reports: Written reports specified in Part 3.
- G. Operation and Maintenance Data: For cable trays to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
- B. Source Limitations: Obtain cable tray components through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NEMA VE 1, "Metal Cable Tray Systems," if cable tray types specified are defined in the standard.
- E. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of cable trays and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, firesuppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B-Line Systems, Inc.
 - 2. Chalfant Cable Trays.
 - 3. GS Metals Corp.
 - 4. Mono-Systems, Inc.
 - 5. MPHusky.
 - 6. P-W Industries, Inc.
 - 7. Thomas & Betts Corporation.

2.2 MATERIALS AND FINISHES

- A. Cable Trays, Fittings, and Accessories: Aluminum, complying with Aluminum Association's alloy 6063-T6 for rails, rungs, and cable trays, and alloy 5052-H32 or alloy 6061-T6 for fabricated parts.
- B. Protect steel hardware against corrosion by galvanizing according to ASTM B 633 or cadmium plating according to ASTM B 766.
- C. Fabricate cable tray products with rounded edges and smooth surfaces.
- D. Sizes and Configurations: Refer to the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

2.3 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Covers: Ventilated-hat type of same materials and finishes as cable tray.
- C. Barrier Strips: Same materials and finishes as cable tray.
- D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 WARNING SIGNS

- A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."
- B. Materials and fastening are specified in Division 16 Section "Electrical Identification."

2.5 SOURCE QUALITY CONTROL

A. Perform design and production tests according to NEMA VE 1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CABLE TRAY INSTALLATION

- A. Remove burrs and sharp edges from cable trays.
- B. Fasten cable tray supports securely to building structure as specified in Division 16 Section "Electrical Supports and Seismic Restraints," unless otherwise indicated.
 - 1. Locate and install supports according to NEMA VE 1.
- C. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independently of fittings. Do not carry weight of cable tray on equipment enclosure.
- D. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed 90 feet (27 m). Space connectors and set gaps according to NEMA VE 1.
- E. Make changes in direction and elevation using standard fittings.
- F. Make cable tray connections using standard fittings.
- G. Locate cable tray above piping unless accessibility to cable tray is required or unless otherwise indicated.
- H. Seal penetrations through fire and smoke barriers according to Division 7 Section "Through-Penetration Firestop Systems."

- I. Sleeves for Future Cables: Install capped sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- J. Workspace: Install cable trays with sufficient space to permit access for installing cables.
- K. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
- L. Install covers after installation of cable is completed.
- M. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

3.3 CONNECTIONS

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

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. After installing cable trays and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform the following electrical test and visual and mechanical inspections:
 - a. Visually inspect each cable tray joint and each ground connection for mechanical continuity.
 - b. Measure ground resistance of each system of cable tray from the most remote element to the point where connection is made to service disconnect enclosure grounding terminal. Record resistance in ohms.
 - 3. Report results in writing.

3.5 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure cable tray is without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 16139

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Single and duplex receptacles, ground-fault circuit interrupters, integral surge suppression units, and isolated-ground receptacles.
 - 2. Single- and double-pole snap switches and dimmer switches.
 - 3. Device wall plates.
 - 4. Pin and sleeve connectors and receptacles.
 - 5. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. PVC: Polyvinyl chloride.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Field quality-control test reports.

1.5 QUALITY ASSURANCE

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

1.6 COORDINATION

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

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Service/Power Poles: One for every 10 , but no fewer than one.
 - 2. Floor Service Outlet Assemblies: One for every 10, but no fewer than one.
 - 3. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.
 - 4. TVSS Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Wiring Devices:
 - a. Bryant Electric, Inc./Hubbell Subsidiary.
 - b. Eagle Electric Manufacturing Co., Inc.
 - c. Hubbell Incorporated; Wiring Device-Kellems.
 - d. Leviton Mfg. Company Inc.
 - e. Pass & Seymour/Legrand; Wiring Devices Div.
 - 2. Wiring Devices for Hazardous (Classified) Locations:

- a. Crouse-Hinds/Cooper Industries, Inc.; Arrow Hart Wiring Devices.
- b. EGS/Appleton Electric Company.
- c. Killark Electric Manufacturing Co./Hubbell Incorporated.
- 3. Multioutlet Assemblies:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Wiremold Company (The).
- 4. Poke-Through, Floor Service Outlets and Telephone/Power Poles:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Pass & Seymour/Legrand; Wiring Devices Div.
 - c. Square D/Groupe Schneider NA.
 - d. Thomas & Betts Corporation.
 - e. Wiremold Company (The).

2.2 RECEPTACLES

- A. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498.
- B. Straight-Blade and Locking Receptacles: Heavy-Duty grade.
- C. GFCI Receptacles: Straight blade, non-feed-through type, Heavy-Duty Specification grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter.
- D. Isolated-Ground Receptacles: Straight blade, Heavy-Duty Specification grade, duplex receptacle, with equipment grounding contacts connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap.
 - 1. Devices: Listed and labeled as isolated-ground receptacles.
 - 2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.
- E. TVSS Receptacles: Straight blade, NEMA WD 6, Configuration 5-20R, with integral TVSS in line to ground, line to neutral, and neutral to ground.
 - 1. TVSS Components: Multiple metal-oxide variators; with a nominal clamp level rating of 500 volts and minimum single transient pulse energy dissipation of 140 J line to neutral, and 70 J line to ground and neutral to ground.
 - Active TVSS Indication: Visual and audible with light visible in face of device to indicate device is "active" or "no longer in service."
 - 3. Receptacle Type: Heavy-Duty Specification grade, with isolatedground terminal.
 - 4. Identification: Distinctive marking on face of device to denote TVSS-type unit.

- F. Industrial Heavy-Duty Pin and Sleeve Devices: Comply with IEC 309-1.
- G. Hazardous (Classified) Location Receptacles: Comply with NEMA FB 11.

2.3 PENDANT CORD/CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, Heavy-Duty grade.
 - 1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 - 2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.4 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.5 SWITCHES

- A. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.
- B. Snap Switches: Heavy-Duty Specification grade, quiet type.
- C. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
 - 1. Switch: 20 A, 120/277-V ac.
 - 2. Receptacle: NEMA WD 6, Configuration 5-20R.
- D. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
 - 1. Control: Continuously adjustable slider; with single-pole or three-way switching to suit connections.
 - 2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle switch, or slider; single pole with soft tap or other quiet switch; EMI/RFI filter to eliminate interference; and 5-inch (130-mm) wire connecting leads.
 - 3. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming;
dimmer-ballast combination capable of consistent dimming with low end not greater than 10 percent of full brightness.

2.6 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.035-inch- (1-mm-) thick, satinfinished stainless steel.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Wet Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

2.7 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular, die-cast aluminum with satin finish.
- D. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 Category 6 jacks for UTP cable.

2.8 POKE-THROUGH ASSEMBLIES

- A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
 - 1. Service Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks.
 - 2. Size: Selected to fit nominal 3-inch (75-mm) cored holes in floor and matched to floor thickness.
 - 3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 - 4. Closure Plug: Arranged to close unused 3-inch (75-mm) cored openings and reestablish fire rating of floor.
 - 5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors; and a minimum of four, 4-pair, Category 6 voice and data communication cables.

2.9 MULTIOUTLET ASSEMBLIES

- A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- B. Raceway Material: Metal, with manufacturer's standard finish.
- C. Wire: No. 12 AWG.

2.10 FINISHES

- A. Color:
 - 1. Wiring Devices Connected to Normal Power System: Gray or as selected by Architect, unless otherwise indicated or required by NFPA 70.
 - 2. Wiring Devices Connected to Emergency Power System: Red.
 - 3. TVSS Devices: Blue.
 - 4. Isolated-Ground Receptacles: Orange.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies level, plumb, and square with building lines.
- B. Install wall dimmers to achieve indicated rating after derating for ganging according to manufacturer's written instructions.
- C. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.
- D. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- E. Remove wall plates and protect devices and assemblies during painting.
- F. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

- A. Comply with Division 16 Section "Electrical Identification."
 - 1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- 3.4 FIELD QUALITY CONTROL
 - A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
 - 2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
 - B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 16140

SECTION 16145

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Time switches.
 - 2. Outdoor and indoor photoelectric switches.
 - 3. Switch-box occupancy sensors.
 - 4. Indoor occupancy sensors.
 - 5. Outdoor motion sensors.
 - 6. Multipole contactors.
- B. Related Sections include the following:
 - 1. Division 13 Section "Lighting Controls" for low-voltage, manual and programmable lighting control systems.
 - 2. Division 16 Section "Wiring Devices" for wall-box dimmers and manual light switches.
 - 3. Division 16 Section "Dimming Controls" for architectural dimming system equipment.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and lightlevel sensors.
 - 1. Lighting plan showing location, orientation, and coverage area of each sensor.
 - 2. Interconnection diagrams showing field-installed wiring.

- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

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

1.6 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.3 TIME SWITCHES

- A. Manufacturers:
 - 1. Area Lighting Research, Inc.
 - 2. Fisher Pierce.
 - 3. Grasslin Controls Corporation.
 - 4. Intermatic, Inc.
 - 5. Leviton Mfg. Company Inc.
 - 6. Lightolier Controls; a Genlyte Company.
 - 7. Lithonia Lighting.
 - 8. Paragon Electric Co.
 - 9. Square D.

- 10. TORK.
- 11. Touchplate Technologies, Inc.
- 12. Watt Stopper (The).
- B. Digital Time Switches: Electronic, solid-state programmable units with alphanumeric display complying with UL 917.
 - 1. Contact Configuration: DPST or as indicated on the drawings.
 - 2. Contact Rating: 30-A inductive or resistive, 240-V ac.
 - 3. Programs: 12 channels.
 - a. For each channel, 40 on-off operations per week, plus 4 seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.
 - 4. Circuitry: Allow connection of a photoelectric relay as substitute for on and off function of a program on selected channels.
 - 5. Astronomical Time: All channels.
 - 6. Battery Backup: For schedules and time clock.

2.4 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers:
 - 1. Area Lighting Research, Inc.
 - 2. Fisher Pierce.
 - 3. Grasslin Controls Corporation.
 - 4. Intermatic, Inc.
 - 5. Lithonia Lighting.
 - 6. Novitas, Inc.
 - 7. Paragon Electric Co.
 - 8. Square D.
 - 9. TORK.
 - 10. Touchplate Technologies, Inc.
 - 11. Watt Stopper (The).
- B. Description: Solid state, with DPST dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; and complying with UL 773.
 - 1. Light-Level Monitoring Range: 1.5 to 10 fc (16 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
 - 2. Time Delay: 15-second minimum, to prevent false operation.
 - 3. Surge Protection: Metal-oxide varistor type, complying with IEEE C62.41 for Category Al locations.
 - 4. Mounting: Twist lock complying with IEEE C136.10, with base. Provide with stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the North sky exposure.

2.5 SWITCH-BOX OCCUPANCY SENSORS

- A. Manufacturers:
 - 1. Bryant Electric; a Hubbell Company.
 - 2. Hubbell Lighting Inc.
 - 3. Leviton Mfg. Company Inc.
 - 4. Lightolier Controls; a Genlyte Company.
 - 5. Lithonia Lighting.
 - 6. MYTECH Corporation.
 - 7. Novitas, Inc.
 - 8. RAB Electric Manufacturing, Inc.
 - 9. Sensor Switch, Inc.
 - 10. TORK.
 - 11. Unenco Electronics; a Hubbell Company.
 - 12. Watt Stopper (The).
- B. Description: PIR type with integral power-switching contacts rated for 800 W at 120-V ac, suitable for incandescent light fixtures, flourescent light fixtures with magnetic or electronic ballasts, or 1/6-hp motors; and rated for 1000 W at 277-V ac, suitable for incandescent light fixtures, flourescent light fixtures with magnetic or electronic ballasts, or 1/3-hp motors, minimum.
 - 1. Include ground wire.
 - Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (215 to 2150 lx); keeps lighting off when selected lighting level is present.
- 2.6 INDOOR OCCUPANCY SENSORS
 - A. Manufacturers:
 - 1. Hubbell Lighting Inc.
 - 2. Leviton Mfg. Company Inc.
 - 3. Lithonia Lighting.
 - 4. MYTECH Corporation.
 - 5. Novitas, Inc.
 - 6. RAB Electric Manufacturing, Inc.
 - 7. Sensor Switch, Inc.
 - 8. TORK.
 - 9. Unenco Electronics; a Hubbell Company.
 - 10. Watt Stopper (The).
 - B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
 - Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

- 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
- 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - Relay: Externally mounted though a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
- 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
- 6. Bypass Switch: Override the on function in case of sensor failure.
- Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (215 to 2150 lx); keeps lighting off when selected lighting level is present.
- C. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.
 - 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch (150-mm) minimum movement of any portion of a human body that presents a target of at least 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving at least 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 - Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.7 OUTDOOR MOTION SENSORS (PIR)

- A. Manufacturers:
 - 1. Bryant Electric; a Hubbell Company.
 - 2. Hubbell Lighting Inc.
 - 3. Lithonia Lighting.
 - 4. Paragon Electric Co.
 - 5. RAB Electric Manufacturing, Inc.
 - 6. TORK.
 - 7. Watt Stopper (The).
- B. General Description: Suitable for operation in ambient temperatures ranging from minus 40 deg F (40 deg C) to 130 deg F (54 deg C), UL 773A rated as raintight.

- 1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
- Sensor Output: Suitable for switching 300 W of tungsten load at 120- or 277-V ac. Lampholders shall comply with UL 1598 for wet locations.
- 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
- 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
 - b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
- 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
- 6. Bypass Switch: Override the on function in case of sensor failure.
- Automatic Light-Level Sensor: Adjustable from 1 to 20 fc (11 to 215 lx); keeps lighting off during daylight hours.
- C. Detector Sensitivity: Detect occurrences of 6-inch (150-mm) minimum movement of any portion of a human body that presents a target of at least 36 sq. in. (232 sq. cm)
- D. Detection Coverage: Up to 35 feet (11 m), with a field of view of 180 degrees.
- 2.8 MULTIPOLE CONTACTORS
 - A. Manufacturers:
 - 1. Allen-Bradley/Rockwell Automation.
 - 2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 - 3. Cutler-Hammer; Eaton Corporation.
 - 4. Fisher Pierce.
 - 5. GE Industrial Systems; Total Lighting Control.
 - 6. Grasslin Controls Corporation.
 - 7. Hubbell Lighting Inc.
 - 8. Lithonia Lighting.
 - 9. MicroLite Corporation.
 - 10. TORK.
 - 11. Touchplate Technologies, Inc.
 - 12. Watt Stopper (The).
 - B. Description: Electrically operated and **mechanically** held, complying with NEMA ICS 2 and UL 508.

- 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
- 2. Control-Coil Voltage: Match control power source.

2.9 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG, complying with Division 16 Section "Conductors and Cables".
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 18 AWG, complying with Division 16 Section "Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 14 AWG, complying with Division 16 Section "Conductors and Cables."
- D. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Division 16 Section "Voice and Data Communication Cabling."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 16 Section "Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

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

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."
- B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify actuation of each sensor and adjust time delays.
- B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION 16145

SECTION 16289

TRANSIENT VOLTAGE SUPPRESSION

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 TVSSs for low-voltage power, control, and communication equipment.
- B. Related Sections include the following:
 - 1. Division 16 Section "Wiring Devices" for devices with integral TVSSs.
 - 2. Division 16 Section "Switchboards" for factory-installed TVSSs.
 - 3. Division 16 Section "Panelboards" for factory-installed TVSSs.

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. SVR: Suppressed voltage rating.
- C. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.
- B. Product Certificates: For transient voltage suppression devices, signed by product manufacturer certifying compliance with the following standards:

UL 1283.
UL 1449 2nd Edition (2005).

- C. Field quality-control test reports, including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.

- 3. Failed test results and corrective action taken to achieve requirements.
- D. Operation and Maintenance Data: For transient voltage suppression devices to include in emergency, operation, and maintenance manuals.
- E. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."
- E. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."
- F. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449 2nd Edition, "Transient Voltage Surge Suppressors."

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- B. Service Conditions: Rate surge protection 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 (6090 m) above sea level.

1.7 COORDINATION

- A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.
- B. Coordinate surge protection devices with Division 16 Section "Electrical Power Monitoring and Control" (if present).

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.
- B. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advanced Protection Technologies, Inc.
 - 2. Atlantic Scientific.
 - 3. Current Technology, Inc.
 - 4. Cutler-Hammer, Inc.; Eaton Corporation.
 - 5. Entrelec International.
 - 6. General Electric Company.
 - 7. Innovative Technology, Inc.
 - 8. Intermatic, Inc.
 - 9. LEA International.
 - 10. Leviton Mfg. Company Inc.
 - 11. Liebert Corporation; a division of Emerson.
 - 12. Siemens Energy & Automation, Inc.
 - 13. Square D; Schneider Electric.
 - 14. Surge Suppression Incorporated.
 - 15. United Power Corporation.

2.2 SERVICE ENTRANCE SUPPRESSORS

- A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
 - 1. LED indicator lights for power and protection status.
 - 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 - 3. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
- B. Surge Protection Device Description: Modular design with fieldreplaceable modules, sine-wave-tracking type with the following features and accessories:
 - 1. Fuses, rated at 200-kA interrupting capacity.
 - 2. Fabrication using bolted compression lugs for internal wiring.
 - 3. Integral disconnect switch.
 - 4. Redundant suppression circuits.
 - 5. Redundant replaceable modules.
 - 6. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
 - 7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - 8. LED indicator lights for power and protection status.
 - 9. Audible alarm, with silencing switch, to indicate when protection has failed.
 - One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
 - 11. Surge-event operations counter.
- C. Peak Single-Impulse Surge Current Rating: 320 kA per phase.
- D. Connection Means: Permanently wired.
- E. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall be as follows:
 - 1. Line to Neutral: 400 V.
 - 2. Line to Ground: 400 V.
 - 3. Neutral to Ground: 400 V.
- F. Protection modes and UL 1449 SVR for 240/120-V, single-phase, 3-wire circuits shall be as follows:
 - 1. Line to Neutral: 400 V.
 - 2. Line to Ground: 400 V.
 - 3. Neutral to Ground: 400 V.
- G. Protection modes and UL 1449 SVR for voltages of 240, 480, or 600, 3phase, 3-wire, delta circuits shall be as follows:
 - 1. Line to Line: 1000 V for 240 V.
 - 2. Line to Ground: 1000 V for 240 V.

2.3 PANELBOARD SUPPRESSORS

- A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
 - 1. LED indicator lights for power and protection status.
 - 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 - 3. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
- B. Surge Protection Device Description: Modular design with fieldreplaceable modules, sign-wave-tracking type with the following features and accessories:
 - 1. Fuses, rated at 200-kA interrupting capacity.
 - 2. Fabrication using bolted compression lugs for internal wiring.
 - 3. Integral disconnect switch.
 - 4. Redundant suppression circuits.
 - 5. Redundant replaceable modules.
 - Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - 7. LED indicator lights for power and protection status.
 - 8. Audible alarm, with silencing switch, to indicate when protection has failed.
 - One set of dry contacts rated at 5 A and 250-V, ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
 - 10. Surge-event operations counter.
- C. Peak Single-Impulse Surge Current Rating: 160 kA per phase.
- D. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall be as follows:
 - 1. Line to Neutral: 400 V.
 - 2. Line to Ground: 400 V.
 - 3. Neutral to Ground: 400 V.
- E. Protection modes and UL 1449 SVR for 240/120-V, single-phase, 3-wire circuits shall be as follows:
 - 1. Line to Neutral: 400 V.
 - 2. Line to Ground: 400 V.
 - 3. Neutral to Ground: 400 V.
- F. Protection modes and UL 1449 SVR for voltages of 240, 480, or 600, 3phase, 3-wire, delta circuits shall be as follows:
 - 1. Line to Line: 1000 V for 240 V.
 - 2. Line to Ground: 800 V for 240 V.

2.4 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

- A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install devices for panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 - 1. Provide multipole, 100-A circuit breaker as a dedicated disconnect for suppressor, unless otherwise indicated.

3.2 PLACING SYSTEM INTO SERVICE

A. Do not energize or connect service entrance equipment to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation, including connections and to assist in field testing. Report results in writing.
 - 1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. Testing: Perform the following field tests and inspections and prepare test reports:
 - 1. After installing surge protection 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, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
- C. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transient voltage suppression devices. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 16289

SECTION 16400

MAIN ELECTRICAL SERVICE

PART 1 GENERAL

1.1 SCOPE

A. The Electrical Contractor shall furnish and install an electric service entrance and related distribution equipment as indicated on the floor plan, diagrams, schedules, specifications, and notes. All equipment shall be new and UL listed.

1.2 ELECTRICAL SERVICE

- A. Secondary service will be 120/208 volts, 3 phase, 4 wire, 60 hertz AC.
- B. The Electrical Contractor shall make all arrangements with the electric utility company and pay all charges made by the electric utility for permanent electric service to the project. In the event that the electric utility's charges are not available at the time the project is bid, the Electrical Contractor shall include a \$10,000 allowance in his bid price to cover any possible utility charges and shall state this in his bid proposal.
- C. The Electrical Contractor shall properly ground the electrical system as required by the National Electrical Code. The ground wire for the service entrance shall be run in conduit and made to the main water service and connected ahead of any valve or cutoff.
- D. The conduit used for service entrance shall be galvanized rigid steel unless otherwise noted on the drawings.
- E. Conductors for the service entrance shall be copper dual rated types THHN/THWN unless otherwise noted. The use of Aluminum conductors in any capacity is strictly prohibited on this contract without the express written permission of the engineer.
- F. The Power Company will furnish and install the primary service cable and the pad mounted transformer, as well as make final connections to the transformer. The Electrical Contractor shall furnish and install the secondary service, the pad for the pad mounted transformer, and the conduit for the primary cable.

1.3 METERING

A. The Electrical Contractor shall provide and install raceway, and install current transformer cabinet and/or meter trim for metering facilities as required by the electric utility serving the project.

The electric utility will provide the meter installation including meter, current transformers, and connections.

- B. Metering will be by the Power Company. Provide one 1¼-inch empty conduit from CT cabinet to the meter base. The Electrical Contractor will provide and install the appropriately sized meter base and CT cabinet. The Power Company will run control wires to the meter. The CT's will be furnished by the Power Company and will be installed by the Electrical Contractor.
- C. The Electrical Contractor shall verify all requirements for the metering, and furnish all miscellaneous components not provided by the utility company at no additional cost to the Owner.

1.4 GROUNDING

A. The conduit systems, neutral conductors and busses for the wiring system, and the telephone system shall be securely grounded. The ground connections shall be National Electrical Code grounds in each case. A ground shall be established an tests carried out to indicate that satisfactory ground has been established in accordance with the National Electrical Code. Written results of this test shall be presented to the Architect immediately upon request if asked for.

END OF SECTION 16400

SECTION 16410

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers.
 - 4. Enclosures.

1.3 DEFINITIONS

- A. GD: General duty.
- B. GFCI: Ground-fault circuit interrupter.
- C. HD: Heavy duty.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current rating.
 - Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Manufacturer Seismic Qualification Certification: Submit certification that enclosed switches and circuit breakers, accessories, and components will withstand seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints." Include the following:
 - 1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Field quality-control test reports including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Manufacturer's field service report.
- F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spares: For the following:
 - a. Potential Transformer Fuses: Six.
 - b. Control-Power Fuses: Six.
 - c. Fuses and Fusible Devices for Fused Circuit Breakers: Six.
 - d. Fuses for Fusible Switches: Three of each size.
 - e. Fuses for Fused Power Circuit Devices: Six.
 - 2. Spare Indicating Lights: Six of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electric Co.; Electrical Distribution & Control Division.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D/Group Schneider.

- B. Fusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Nonfusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
 - 3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.
- 2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES
 - A. Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electric Co.; Electrical Distribution & Control Division.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D/Group Schneider.
 - B. 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; fieldreplaceable 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. Ground-fault pickup level, time delay, and I²t response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
 - 5. GFCI Circuit Breakers: Single- and two-pole configurations with [5] [30]-mA trip sensitivity.
 - C. Molded-Case Circuit-Breaker Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.

- 2. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and conductor material.
- 3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
- 4. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- 5. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 16 Section "Electrical Power Monitoring and Control."
- 6. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
- 7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
- 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.
- 9. Key Interlock Kit: Externally mounted to prohibit circuitbreaker operation; key shall be removable only when circuit breaker is in off position.
- 10. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
- D. Molded-Case Switches: Molded-case circuit breaker with fixed, highset instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- E. Molded-Case Switch Accessories:
 - 1. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and material of conductors.
 - 2. Application Listing: 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. Provide "dummy" trip unit where required for proper operation.
 - 4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay. Provide "dummy" trip unit where required for proper operation.
 - 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.
 - 6. Key Interlock Kit: Externally mounted to prohibit operation; key shall be removable only when switch is in off position.

2.4 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 16 Section "Electrical Supports and Seismic Restraints," and concrete materials and installation requirements are specified in Division 3.

3.3 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.
- C. Comply with mounting and anchoring requirements specified in Division 16 Section "Electrical Supports and Seismic Restraints."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 16 Section "Electrical Identification."

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Prepare for acceptance testing as follows:
 - 1. Inspect mechanical and electrical connections.
 - 2. Verify switch and relay type and labeling verification.
 - 3. Verify rating of installed fuses.
 - 4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. Test mounting and anchorage devices according to requirements in Division 16 Section "Electrical Supports and Seismic Restraints."
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 4. Infrared Scanning:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.
 - b. Follow-Up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.
 - c. Instruments, Equipment and Reports:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - Prepare a certified report that identifies enclosed switches and circuit breakers included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

- A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 16410

SECTION 16415

TRANSFER SWITCHES

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 transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switches.
 - 2. Non-automatic transfer switches.
 - 3. Remote annunciation system.
 - 4. Remote annunciation and control system.
- B. Related Sections include the following:
 - 1. Division 13 Section "Electric-Drive, Centrifugal Fire Pumps" for automatic transfer switches for fire pumps.
 - 2. Division 13 Section "Electric-Drive, Vertical-Turbine Fire Pumps" for automatic transfer switches for fire pumps.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
 - 1. Wiring Diagrams: Single-line diagram. Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
- C. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches, accessories, and components will withstand seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints." Include the following:

- 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: For manufacturer and testing agency.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:
 - 1. Features and operating sequences, both automatic and manual.
 - 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
- B. Source Limitations: Obtain automatic transfer switches, bypass/isolation switches, nonautomatic transfer switches, remote annunciators, and remote annunciator and control panels through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for emergency service under UL 1008, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NEMA ICS 1.
- E. Comply with NFPA 70.
- F. Comply with NFPA 99.
- G. Comply with NFPA 110.
- H. Comply with UL 1008 unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Contactor Transfer Switches:
 - a. Caterpillar; Engine Div.
 - b. Emerson; ASCO Power Technologies, LP.
 - c. Generac Power Systems, Inc.
 - d. GE Zenith Controls.
 - e. Kohler Co.; Generator Division.
 - f. Onan Corp./Cummins Power Generation; Industrial Business Group.
 - g. Russelectric, Inc.
 - h. Spectrum Detroit Diesel.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 - 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
- C. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels have communication capability matched with remote device.
- D. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltageimpulse withstand test of NEMA ICS 1.
- F. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- G. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

- H. Enclosures: General-purpose NEMA 250, Type 3R, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.
- I. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.
- J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.
 - 1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- K. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- L. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

- F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- G. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
- H. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.
- I. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

2.4 AUTOMATIC TRANSFER-SWITCH FEATURES

- A. Undervoltage Sensing for Each Phase of Normal Source: Senses low phase-to-ground voltage on each phase. Pickup voltage is adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
- B. Time delay for override of normal-source voltage sensing delays transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
- C. Voltage/Frequency Lockout Relay: Prevents premature transfer to generator. Pickup voltage is adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency is adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
- D. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes. Provides automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
- E. Test Switch: Simulates normal-source failure.

- F. Switch-Position Pilot Lights: Indicate source to which load is connected.
- G. Source-Available Indicating Lights: Supervise sources via transferswitch normal- and emergency-source sensing circuits.
 - 1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - 2. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
- H. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
- I. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
- J. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
- K. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
- L. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
- M. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - 1. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - 2. Push-button programming control with digital display of settings.
 - 3. Integral battery operation of time switch when normal control power is not available.

2.5 REMOTE ANNUNCIATOR SYSTEM

- A. Functional Description: Remote annunciator panel annunciates conditions for indicated transfer switches. Annunciation includes the following:
 - 1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.

- 2. Switch position.
- 3. Switch in test mode.
- 4. Failure of communication link.
- B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
 - 1. Indicating Lights: Grouped for each transfer switch monitored.
 - 2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
 - 3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
 - 4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.6 FINISHES

- A. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.
- 2.7 SOURCE QUALITY CONTROL
 - A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.
- PART 3 EXECUTION

3.1 APPLICATION

A. Four-Pole Switches: Where four-pole switches are indicated, install neutral switching.

3.2 INSTALLATION

- A. Comply with mounting and anchoring requirements specified in Division 16 Section "Electrical Supports and Seismic Restraints."
- B. Floor-Mounted Switch: Anchor to floor by bolting.
 - 1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 2 inches (50 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated. Cast anchor-bolt inserts into bases. Comply with Division 3 Section "Cast-in-Place Concrete."
- C. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

D. Identify components according to Division 16 Section "Electrical Identification."

3.3 WIRING TO REMOTE COMPONENTS

A. Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

3.4 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.22.3. Certify compliance with test parameters.
 - 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
- 4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- 5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
 - b. Observe reaction of circuit-interrupting devices when simulated fault current is applied at sensors.
- C. Coordinate tests with tests of generator and run them concurrently.
- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- E. Remove and replace malfunctioning units and retest as specified above.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Section "Demonstration and Training."
 - 1. Coordinate this training with that for generator equipment.

END OF SECTION 16415

SECTION 16441

SWITCHBOARDS

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 service and distribution switchboards rated 600 V and less.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of switchboards and overcurrent protective devices.

- d. Descriptive documentation of optional barriers specified for electrical insulation and isolation.
- e. Utility company's metering provisions with indication of approval by utility company.
- f. Mimic-bus diagram.
- g. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples: Representative portion of mimic bus with specified finish, for color selection.
- D. Manufacturer Seismic Qualification Certification: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field quality-control test reports including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- F. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:
 - 1. Routine maintenance requirements for switchboards and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain switchboards and panelboards through one source from a single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NEMA PB 2, "Deadfront Distribution Switchboards."
- E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in sections or lengths that can be moved past obstructions in delivery path.
- B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchboards; install electric heating (250 W per section) to prevent condensation.
- D. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.7 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, liftout panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2000 m).
- C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet (2000 m).
- D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted

under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

- 1. Notify Architect, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of electric service.
- 2. Indicate method of providing temporary electric service.
- 3. Do not proceed with interruption of electric service without Architect's and Owner's written permission.

1.8 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Potential Transformer Fuses: Equal to 10 percent of amount installed for each size and type, but no fewer than 2 of each size and type.
 - 2. Control-Power Fuses: Equal to 10 percent of amount installed for each size and type, but no fewer than 2 of each size and type.
 - 3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
 - 4. Fuses for Fused Switches: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
 - 5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
 - 6. Indicating Lights: Equal to 10 percent of amount installed for each size and type, but no fewer than 1 of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- 2.2 MANUFACTURED UNITS
 - A. Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electric Co.; Electrical Distribution & Protection Div.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D.
 - B. Front-Connected, Front-Accessible Switchboard: Fixed, individually mounted main device, panel-mounted branches, and sections rear aligned.
 - C. Front- and Side-Accessible Switchboard: Fixed, individually mounted main device; panel-mounted branches; and sections rear aligned.
 - D. Nominal System Voltage: 208Y/120 V.
 - E. Main-Bus Continuous: As indicated on Switchboard Schedule.
 - F. Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints."
 - G. Enclosure: Steel, NEMA 250, Type 1.
 - H. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
 - I. Barriers: Between adjacent switchboard sections.
 - J. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
 - 1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
 - 2. Space-Heater Power Source: Transformer, factory installed in switchboard.
 - K. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
 - L. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
 - M. Pull Box on Top of Switchboard:
 - 1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 - 2. Set back from front to clear circuit-breaker removal mechanism.

- 3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
- 4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
- 5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- N. Buses and Connections: Three phase, four wire, unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.
 - 2. Load Terminals: Insulated, rigidly braced, silver-plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full ampere rating of circuitbreaker position.
 - 3. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) minimum-size, harddrawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - 4. Contact Surfaces of Buses: Silver plated.
 - 5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
 - 7. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.
- O. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.3 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 3, 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. Electronic trip-unit circuit breakers (400A and larger) shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:
 - a. Instantaneous trip.

- b. Long- and short-time pickup levels.
- c. Long- and short-time time adjustments.
- d. Ground-fault pickup level, time delay, and I²t response.
- 3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
- 4. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
- 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 conductor material.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system, specified in Division 16 Section "Electrical Power Monitoring and Control."
 - 5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - 7. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 8. Key Interlock Kit: Externally mounted to prohibit circuitbreaker operation; key shall be removable only when circuit breaker is in off position.
 - 9. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

2.4 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
 - 1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
 - Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.
 - 3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.
 - 4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker ground-fault protection.

- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
 - i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
 - 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
- C. Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1.
 - Meters: 4-inch (100-mm) diameter or 6 inches (150 mm) square, flush or semiflush, with antiparallax 250-degree scales and external zero adjustment.
 - 2. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.
- D. Instrument Switches: Rotary type with off position.
 - Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.
 - 2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.
- 2.5 CONTROL POWER
 - A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.
 - B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
 - C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
- C. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.
- D. Fungus Proofing: Permanent fungicidal treatment for switchboard interior, including instruments and instrument transformers.

2.7 IDENTIFICATION

- A. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.
- B. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

PART 3 - EXECUTION

3.1 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.2 EXAMINATION

- A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.

- B. Install and anchor switchboards level on concrete bases, 4-inch (100mm) nominal thickness. Concrete base is specified in Division 16 Section "Electrical Supports and Seismic Restraints," and concrete materials and installation requirements are specified in Division 3.
 - Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450mm) centers around full perimeter of base.
 - 2. For switchboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install spare-fuse cabinet.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."
- B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Perform the following field tests and inspections and prepare test reports:

- 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.
- 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 - c. Instruments, Equipment, and Reports:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2) Prepare a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 16441

SECTION 16442

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Load centers.
 - 4. Transient voltage suppression panelboards.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.

- b. Bus configuration, current, and voltage ratings.
- c. Short-circuit current rating of panelboards and overcurrent protective devices.
- d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints." Include the following:
 - 1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Field quality-control test reports including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section " Closeout Procedures," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - Ambient Temperature: Not exceeding 104 deg F (40 deg C).
 Altitude: Not exceeding 6600 feet (2000 m).
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect, Construction Manager, and Owner no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Architect's, and Owner's written permission.

1.7 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Six spares for each type of panelboard cabinet lock.

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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Eaton Corporation; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Protection Div.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D.

2.2 MANUFACTURED UNITS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints."
- B. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.
 - 1. Rated for environmental conditions at installed location.
 - a. Outdoor Locations: NEMA 250, Type 3R.
 - b. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - d. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
 - Front: Secured to box with concealed trim clamps. For surfacemounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 6. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
 - 7. Finish: Manufacturer's standard enamel finish over corrosionresistant treatment or primer coat.
 - 8. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

- C. Phase and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
 - 3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
 - 4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
 - 5. Split Bus: Vertical buses divided into individual vertical sections.
- D. Conductor Connectors: Suitable for use with conductor material.
 - 1. Main and Neutral Lugs: Mechanical type.
 - 2. Ground Lugs and Bus Configured Terminators: Compression type.
 - 3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 4. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.
- F. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- 2.3 PANELBOARD SHORT-CIRCUIT RATING
 - A. Series rating of equipment or devices is strictly prohibited.
 - B. Fully rated to interrupt symmetrical short-circuit current available at terminals.
- 2.4 DISTRIBUTION PANELBOARDS (xDPx designation)
 - A. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.
 - B. Main Overcurrent Protective Devices: Circuit breaker.
 - C. Branch Overcurrent Protective Devices:
 - 1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
 - 2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

- 2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS (xLx designation)
 - A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
 - B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following fieldadjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I²t response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 5. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
- 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 conductor materials.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 16 Section "Electrical Power Monitoring and Control."
 - 5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - 7. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

- 8. Key Interlock Kit: Externally mounted to prohibit circuitbreaker operation; key shall be removable only when circuit breaker is in off position.
- 9. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
- 10. Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.

2.7 CONTROLLERS

- A. Motor Controllers: NEMA ICS 2, Class A, combination controller equipped for panelboard mounting and including the following accessories:
 - 1. Individual control-power transformers.
 - 2. Fuses for control-power transformers.
 - 3. Bimetallic-element overload relay.
 - 4. Indicating lights.
 - 5. Seal-in contact.
 - 6. Six convertible auxiliary contacts.
 - 7. Push buttons.
 - 8. Selector switches.
- B. Contactors: NEMA ICS 2, Class A, combination controller equipped for panelboard mounting and including the following accessories:
 - 1. Individual control-power transformers.
 - 2. Fuses for control-power transformers.
 - 3. Indicating lights.
 - 4. Seal-in contact.
 - 5. Six convertible auxiliary contacts.
 - 6. Push buttons.
 - 7. Selector switches.
- C. Controller Disconnect Switches: Adjustable instantaneous-trip circuit breaker integrally mounted and interlocked with controller.
 - 1. Auxiliary Contacts: Integral with disconnect switches to deenergize external control-power source.
- D. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held general-purpose controller.
 - 1. Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2.8 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

- B. Furnish portable test set to test functions of solid-state trip devices without removal from panelboard.
- C. Fungus Proofing: Permanent fungicidal treatment for panelboard interior, including overcurrent protective devices and other components.
- PART 3 EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 16 Section "Electrical Supports and Seismic Restraints."
- C. Mount top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.
- D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- E. Install overcurrent protective devices and controllers.

1. Set field-adjustable switches and circuit-breaker trip ranges.

- F. Install filler plates in unused spaces.
- G. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 15 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
- D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 16442

SECTION 16511

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures, lamps, and ballasts.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.
- B. Related Sections include the following:
 - Division 13/16 Section "Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
 - 2. Division 16 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
 - Division 16 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
 - 4. Division 16 Section "Dimming Controls" for architectural dimming systems.

1.3 DEFINITIONS

- A. BF: Ballast factor.
- B. CRI: Color-rendering index.
- C. CU: Coefficient of utilization.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Luminaire: Complete lighting fixture, including ballast housing if provided.

G. RCR: Room cavity ratio.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.
 - 3. Ballast.
 - 4. Energy-efficiency data.
 - 5. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Submittals" Article in Division 15 Section "Diffusers, Registers, and Grilles."
 - 6. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 15 Section "Diffusers, Registers, and Grilles."
 - 7. Life, output, and energy-efficiency data for lamps.
 - 8. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
 - a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
 - b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
 - 1. Wiring Diagrams: Power and control wiring.
- C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Lighting fixtures.
 - 2. Suspended ceiling components.
 - 3. Structural members to which suspension systems for lighting fixtures will be attached.
 - 4. Other items in finished ceiling including the following:
 - a. Air outlets and inlets.
 - b. Speakers.
 - c. Sprinklers.
 - d. Smoke and fire detectors.
 - e. Occupancy sensors.

- f. Access panels.
- 5. Perimeter moldings.
- D. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:
 - 1. Lamps: Specified units installed.
 - 2. Accessories: Cords and plugs.
- E. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.
- F. Qualification Data: For agencies providing photometric data for lighting fixtures.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
- I. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.
- D. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.
- E. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.
 - 1. Obtain Architect's approval of fixtures for mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is

supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

- 1.7 WARRANTY
 - A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
 - 2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.
 - B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.
 - 2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.
 - C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: Two year(s) from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Battery and Charger Data: One for each emergency lighting unit.
 - 4. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
- 2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS
 - A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
 - B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
 - C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
 - D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
 - E. Metal Parts: Free of burrs and sharp corners and edges.
 - F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
 - G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
 - H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metallized Film: 90 percent.
 - I. Plastic Diffusers, Covers, and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

- a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless different thickness is indicated.
- b. UV stabilized.
- 2. Glass: Annealed crystal glass, unless otherwise indicated.
- J. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.
- K. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Division 15 Section "Diffusers, Registers, and Grilles."
 - 1. Air Supply Units: Slots in one or both side trims join with airdiffuser-boot assemblies.
 - 2. Heat Removal Units: Air path leads through lamp cavity.
 - 3. Combination Heat Removal and Air Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air supply units.
 - 4. Dampers: Operable from outside fixture for control of return-air volume.
 - 5. Static Fixture: Air supply slots are blanked off, and fixture appearance matches active units.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. Electronic Ballasts: Comply with ANSI C82.11; programmed-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.
 - 1. Sound Rating: A.
 - 2. Total Harmonic Distortion Rating: Less than 10 percent.
 - 3. Transient Voltage Protection: IEEE C62.41, Category A or better.
 - 4. Operating Frequency: 20 kHz or higher.
 - 5. Lamp Current Crest Factor: 1.7 or less.
 - 6. BF: 0.85 or higher.
 - 7. Power Factor: 0.95 or higher.
 - 8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
- B. Electronic Programmed-Start Ballasts for T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:
 - 1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
 - 2. Automatic lamp starting after lamp replacement.
 - 3. Sound Rating: A.
 - 4. Total Harmonic Distortion Rating: Less than 10 percent.
 - 5. Transient Voltage Protection: IEEE C62.41, Category A or better.
 - 6. Operating Frequency: 20 kHz or higher.

- 7. Lamp Current Crest Factor: 1.7 or less.
- 8. BF: 0.95 or higher, unless otherwise indicated.
- 9. Power Factor: 0.95 or higher.
- C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.
 - 1. Ballast Manufacturer Certification: Indicated by label.
- D. Ballasts for Low-Temperature Environments:
 - 1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic or electromagnetic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
 - 2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.
- E. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.
- F. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
 - 1. Dimming Range: 100 to 5 percent of rated lamp lumens.
 - 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 - 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
- G. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.
 - 1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between highand low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 50 percent of rated lamp lumens.
 - 2. Ballast shall provide equal current to each lamp in each operating mode.
 - 3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bilevel control is indicated:
 - 1. Lamp end-of-life detection and shutdown circuit.
 - 2. Automatic lamp starting after lamp replacement.
 - 3. Sound Rating: A.
 - 4. Total Harmonic Distortion Rating: Less than 20 percent.

- 5. Transient Voltage Protection: IEEE C62.41, Category A or better.
- 6. Operating Frequency: 20 kHz or higher.
- 7. Lamp Current Crest Factor: 1.7 or less.
- 8. BF: 0.95 or higher, unless otherwise indicated.
- 9. Power Factor: 0.95 or higher.
- 10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
- 11. Ballast Case Temperature: 75 deg C, maximum.
- B. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
 - 1. Dimming Range: 100 to 5 percent of rated lamp lumens.
 - 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 - 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

2.5 EMERGENCY FLUORESCENT POWER UNIT

- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
 - 1. Emergency Connection: Operate 1 fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 - 2. Night-Light Connection: Operate one fluorescent lamp continuously.
 - 3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 4. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - 5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 - 6. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - 7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 BALLASTS FOR HID LAMPS

- A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:
 - 1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
 - 2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single-lamp ballasts.
 - 3. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
 - 4. Open-circuit operation that will not reduce average life.
 - 5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.
- B. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:
 - 1. Lamp end-of-life detection and shutdown circuit.
 - 2. Sound Rating: A.
 - 3. Total Harmonic Distortion Rating: Less than 15 percent.
 - 4. Transient Voltage Protection: IEEE C62.41, Category A or better.
 - 5. Lamp Current Crest Factor: 1.5 or less.
 - 6. Power Factor: .90 or higher.
 - 7. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
 - 8. Protection: Class P thermal cutout.
 - 9. Retain subparagraph and associated subparagraphs below for bilevel ballasts.
 - 10. Bi-Level Dimming Ballast: Ballast circuit and leads provide for remote control of the light output of the associated fixture between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 50 percent of rated lamp lumens.
 - c. Compatibility: Certified by ballast manufacturer for use with specific bi-level control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and color-rendering capability.
 - 11. Continuous Dimming Ballast: Dimming range shall be from 100 to 35 percent of rated lamp lumens without flicker.
 - a. Ballast Input Watts: Reduced to a maximum of 50 percent of normal at lowest dimming setting.
 - b. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated. Certified by lamp manufacturer that ballast operating modes are free from negative effect on lamp life and colorrendering capability.
- C. Auxiliary Instant-On Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when power outages occur. System automatically turns

quartz lamp off when HID lamp reaches approximately 60 percent light output.

- D. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter-starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
 - 1. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
 - a. Restrike Range: 105- to 130-V ac.
 - b. Maximum Voltage: 250-V peak or 150-V ac RMS.
 - 2. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).
 - 3. Open-circuit operation shall not reduce average lamp life.

2.7 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: Fluorescent, 2 for each fixture, 20,000 hours of rated lamp life.
 - Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
 - 3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency

operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.8 EMERGENCY LIGHTING UNITS

- A. Description: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
 - 7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
 - 8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - 9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.9 FLUORESCENT LAMPS

- A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.
- B. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life 20,000 hours, unless otherwise indicated.
- C. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life of 20,000 hours, unless otherwise indicated.
- D. T5 rapid-start low-mercury lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85

(minimum), color temperature 4100 K, and average rated life of 20,000 hours, unless otherwise indicated.

- E. T5HO rapid-start, high-output low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours, unless otherwise indicated.
- F. Compact Fluorescent Lamps: 4-Pin, low mercury, CRI 80 (minimum), color temperature 4100 K, average rated life of 10,000 hours at 3 hours operation per start, and suitable for use with dimming ballasts, unless otherwise indicated.
 - 1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
 - 2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
 - 3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
 - 4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
 - 5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
 - 6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

2.10 HID LAMPS

- A. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900 K, and average rated life of 24,000 hours, minimum.
 - 1. Dual-Arc Tube Lamps: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.
- B. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.
- C. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.
- D. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

2.11 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 16 Section "Electrical Supports and Seismic Restraints" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).
- F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- 2.12 RETROFIT KITS FOR FLUORESCENT LIGHTING FIXTURES
 - A. Comply with UL 1598 listing requirements.
 - Reflector Kit: UL 1598, Type I. Suitable for two- to four-lamp, surface-mounted or recessed lighting fixtures by improving reflectivity of fixture surfaces.
 - 2. Ballast and Lamp Change Kit: UL 1598, Type II. Suitable for changing existing ballast, lamps, and sockets.
- PART 3 EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
 - Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- C. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

- 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- D. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.
- E. Adjust aimable lighting fixtures to provide required light intensities.
- F. Connect wiring according to Division 16 Section "Conductors and Cables."
- 3.2 FIELD QUALITY CONTROL
 - A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
 - B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 16511
SECTION 16521

EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Exterior luminaires with lamps and ballasts.
 - 2. Luminaire-mounted photoelectric relays.
 - 3. Poles and accessories.
 - 4. Luminaire lowering devices.
- B. Related Sections include the following:
 - 1. Division 16 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

- A. CRI: Color-rendering index.
- B. HID: High-intensity discharge.
- C. Luminaire: Complete lighting fixture, including ballast housing if provided.
- D. Pole: Luminaire support structure, including tower used for large area illumination.
- E. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.
- B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4.

- C. Ice Load: Load of 3 lbf/sq. ft. (143.6 Pa), applied as stated in AASHTO LTS-4.
- D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.
 - 1. Wind speed for calculating wind load for poles exceeding 50 feet (15 m) in height is 110 mph (177 km/h).
 - 2. Wind speed for calculating wind load for poles 50 feet (15 m) or less in height is 70 mph (113 km/h).

1.5 SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
 - 2. Details of attaching luminaires and accessories.
 - 3. Details of installation and construction.
 - 4. Luminaire materials.
 - 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
 - a. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - 6. Photoelectric relays.
 - 7. Ballasts, including energy-efficiency data.
 - 8. Lamps, including life, output, and energy-efficiency data.
 - 9. Materials, dimensions, and finishes of poles.
 - 10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
 - 11. Anchor bolts for poles.
 - 12. Manufactured pole foundations.
- B. Shop Drawings:
 - 1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
 - 2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
 - 3. Wiring Diagrams: Power and control wiring.
- C. Samples for Verification: For products designated for sample submission in Exterior Lighting Device Schedule. Each sample shall include lamps and ballasts.
- D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load

requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

- E. Qualification Data: For agencies providing photometric data for lighting fixtures.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with IEEE C2, "National Electrical Safety Code."
- D. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.

- 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
- 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
- 4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
- 5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Ballasts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Globes and Guards: 10 for every 20 of each type and rating installed. Furnish at least one of each type.
- PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factoryassembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

- 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected by Architect from manufacturer's full range.
- N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: As selected by the architect.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Comply with UL 773 or UL 773A.
- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
 - 1. Relay with locking-type receptacle shall comply with NEMA C136.10.
 - 2. Adjustable window slide for adjusting on-off set points.

2.4 FLUORESCENT BALLASTS AND LAMPS

- A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures minus 20 deg F (minus 29 deg C) and higher.
- B. Ballast Characteristics:
 - 1. Power Factor: 90 percent, minimum.
 - 2. Sound Rating: A.

- 3. Total Harmonic Distortion Rating: Less than 10 percent.
- 4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving,
- high power factor, Class P, automatic-reset thermal protection.
- 5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
- 6. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.
- C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures minus 20 deg F (minus 29 deg C) and higher.
- D. Fluorescent Lamps: Low-mercury type. Comply with the EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

2.5 BALLASTS FOR HID LAMPS

- A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features, unless otherwise indicated:
 - 1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
 - 2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).
 - 3. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
 - 4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
- B. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.
- C. High-Pressure Sodium Ballasts: Electromagnetic type with solid-state igniter/starter and capable of open-circuit operation without reduction of average lamp life. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
 - Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
 - a. Restrike Range: 105- to 130-V ac.
 - b. Maximum Voltage: 250-V peak or 150-V ac RMS.
 - 2. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).

2.6 HID LAMPS

A. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900 K, and average rated life of 24,000 hours, minimum.

- 1. Dual-Arc Tube Lamp: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.
- B. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.
- C. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.
- D. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.
- 2.7 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS
 - A. Structural Characteristics: Comply with AASHTO LTS-4.
 - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
 - 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
 - B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
 - C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - 1. Materials: Shall not cause galvanic action at contact points.
 - Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
 - 3. Anchor-Bolt Template: Plywood or steel.
 - D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."
 - E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
 - F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.8 POLE ACCESSORIES

- A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 16 Section "Wiring Devices" for ground-fault circuitinterrupter type.
 - 1. Recessed, 12 inches (300 mm) above finished grade.
 - 2. Nonmetallic polycarbonate plastic or reinforced fiberglass cover, that when mounted results in NEMA 250, Type 3R enclosure.
 - 3. With cord opening.
 - 4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.
- B. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.
- C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.
- D. Transformer Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and accept ballast(s).

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.2 POLE INSTALLATION

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
 - 1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
 - Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
 - 3. Trees: 15 feet (5 m).

- C. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
 - 1. Make holes 6 inches (150 mm) in diameter larger than pole diameter.
 - 2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi (20 MPa) at 28 days, and finish in a dome above finished grade.
 - 3. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
 - 4. Cure concrete a minimum of 72 hours before performing work on pole.
- D. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.
- E. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Castin-Place Concrete."

3.5 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 16 Section "Raceways and Boxes." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

- A. Ground metal poles and support structures according to Division 16 Section "Grounding and Bonding."
 - 1. Install grounding electrode for each pole, unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Division 16 Section "Grounding and Bonding."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundations.

3.7 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 - 1. Verify operation of photoelectric controls.
- C. Illumination Tests:
 - Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting."
 - b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
 - c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
 - d. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - e. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 1 Section "Demonstration and Training." END OF SECTION 16521

SECTION 16721

FIRE ALARM

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 fire alarm systems.
- B. Related Sections include the following:
 - 1. Division 8 Section "Door Hardware" for door closers and holders with associated smoke detectors, electric door locks, and release devices that interface with the fire alarm system.

1.3 DEFINITIONS

- A. FACP: Fire alarm control panel.
- B. LED: Light-emitting diode.
- C. NICET: National Institute for Certification in Engineering Technologies.
- D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

A. Noncoded, addressable system; multiplexed signal transmission dedicated to fire alarm service only.

1.5 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 72.
- B. Premises protection includes public area and private guest rooms.
- C. Fire alarm signal initiation shall be by one or more of the following devices:
 - 1. Manual stations.

- 2. Heat detectors.
- 3. Smoke detectors.
- 4. Verified automatic alarm operation of smoke detectors.
- 5. Automatic sprinkler system water flow.
- 6. Fire extinguishing system operation.
- 7. Fire standpipe system.
- D. Fire alarm signal shall initiate the following actions:
 - 1. Alarm notification appliances shall operate continuously.
 - 2. Identify alarm at the FACP and remote annunciators.
 - 3. De-energize electromagnetic door holders.
 - 4. Transmit an alarm signal to the remote alarm receiving station.
 - 5. Unlock electric door locks in designated egress paths.
 - 6. Release fire and smoke doors held open by magnetic door holders.
 - 7. Activate voice/alarm communication system.
 - 8. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
 - 9. Close smoke dampers in air ducts of system serving zone where alarm was initiated.
 - 10. Record events in the system memory.
 - 11. Record events by the system printer.
- E. Supervisory signal initiation shall be by one or more of the following devices or actions:
 - 1. Operation of a fire-protection system valve tamper.
- F. System trouble signal initiation shall be by one or more of the following devices or actions:
 - 1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
 - 2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
 - 3. Loss of primary power at the FACP.
 - 4. Ground or a single break in FACP internal circuits.
 - 5. Abnormal ac voltage at the FACP.
 - 6. A break in standby battery circuitry.
 - 7. Failure of battery charging.
 - 8. Abnormal position of any switch at the FACP or annunciator.
 - 9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
 - 10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.
- G. System Trouble and Supervisory Signal Actions: Ring trouble bell and annunciate at the FACP and remote annunciators. Record the event on system printer.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:

- 1. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire alarm system design.
 - b. Fire alarm certified by NICET, minimum Level III.
- 2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
- 3. Device Address List: Coordinate with final system programming.
- 4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.
- 5. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
- 6. Batteries: Size calculations.
- 7. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
- 8. Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
- 9. Voice/Alarm Signaling Service: Equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
- 10. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
- C. Qualification Data: For Installer.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, Appendix A, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.
- F. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 1 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.

G. Documentation:

- 1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and authorities having jurisdiction.
- 2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.
 - a. Hard copies on paper to Owner, Architect, and authorities having jurisdiction.
 - b. Electronic media may be provided to Architect and authorities having jurisdiction.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level III.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
 - 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
 - 3. Smoke, Fire, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
 - 4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
 - 5. Keys and Tools: One extra set for access to locked and tamperproofed components.
 - 6. Audible and Visual Notification Appliances: One of each type installed.
 - 7. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. FACP and Equipment:
 - a. Edwards Systems Technology Inc.
 - b. Fire Control Instruments, Inc.; a GE-Honeywell Company.
 - c. Fire-Lite Alarms; a GE-Honeywell Company.
 - d. Gamewell Company (The).
 - e. Grinnell Fire Protection; a Tyco International Company.
 - f. NOTIFIER; a GE-Honeywell Company.
 - g. Siemens Building Technologies, Inc.; a Cerberus Division.
 - h. Silent Knight; a GE-Honeywell Company.
 - i. SimplexGrinnell LP; a Tyco International Company.
- 2. Wire and Cable:
 - a. Comtran Corporation.
 - b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
 - c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
 - d. West Penn Wire/CDT; a division of Cable Design Technologies.
- 3. Audible and Visual Signals:
 - a. Amseco; a division of Kobishi America, Inc.
 - b. Commercial Products Group.
 - c. Gentex Corporation.
 - d. System Sensor; a GE-Honeywell Company.

2.2 FACP

- A. General Description:
 - 1. Modular, power-limited design with electronic modules, UL 864 listed.
 - 2. Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at the FACP.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 - 3. Addressable control circuits for operation of mechanical equipment.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
 - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands; and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:

- 1. Signaling Line Circuits: NFPA 72, Class A, Style 2.
 - a. System Layout: Install no more than 50 addressable devices on each signaling line circuit.
- 2. Notification-Appliance Circuits: NFPA 72, Class B, Style W.
- 3. Actuation of alarm notification appliances, annunciation, smoke control, elevator recall, and actuation of suppression systems shall occur within 10 seconds after the activation of an initiating device.
- 4. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.
- D. Smoke-Alarm Verification:
 - 1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
 - 2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
 - 3. Record events by the system printer.
 - 4. Sound general alarm if the alarm is verified.
 - 5. Cancel FACP indication and system reset if the alarm is not verified.
- E. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41.
- F. Elevator Controls: Heat detector operation shuts down elevator power by operating a shunt trip in a circuit breaker feeding the elevator.
- G. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.
- H. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators, after initiating devices are restored to normal.
 - 1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
 - 2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
 - 3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.
- I. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If

testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

- J. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivityadjustment schedule changes in system memory, and make a print-out of the final adjusted values on the system printer.
- K. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a digital alarm communicator transmitter and telephone lines.
- L. Voice/Alarm Signaling Service: A central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of the FACP.
 - 1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones, or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall be UL 1711 listed.
 - a. Allow the application of and evacuation signal to indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
 - d. Generate tones to be sequenced with audio messages of the type recommended by NFPA 72 and that are compatible with tone patterns of the notification-appliance circuits of the FACP.
 - 2. Notification-Appliance Circuits: NFPA 72, Class A.
 - Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
 - 4. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- M. Service Modem: Ports shall be RS-232 for system printer and for connection to a dial-in terminal unit.
 - 1. The dial-in port shall allow remote access to the FACP for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.
- N. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble), and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including the same

information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

- O. Primary Power: 24-V dc obtained from 120-V ac service and a powersupply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory and digital alarm communicator transmitter shall be powered by the 24-V dc source.
 - 1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
 - 2. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM SYSTEM POWER."
- P. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.
 - 1. Batteries: Sealed lead calcium.
 - 2. Battery and Charger Capacity: Comply with NFPA 72.
- Q. Surge Protection:
 - 1. Install surge protection on normal ac power for the FACP and its accessories. Comply with Division 16 Section "Transient Voltage Suppression" for auxiliary panel suppressors.
- R. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.3 MANUAL FIRE ALARM BOXES

- A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.
 - 1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
 - 2. Station Reset: Key-operated switch.
 - 3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
 - 4. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm.

2.4 SYSTEM SMOKE DETECTORS

- A. General Description:
 - 1. UL 268 listed, operating at 24-V dc, nominal.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 - 3. Multipurpose type, containing the following:
 - a. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 - b. Piezoelectric sounder rated at 88 dBA at 10 feet (3 m) according to UL 464.
 - c. Heat sensor, combination rate-of-rise and fixed temperature.
 - 4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
 - 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
 - 7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
 - a. Rate-of-rise temperature characteristic shall be selectable at the FACP for 15 or 20 deg F (8 or 11 deg C) per minute.
 - b. Fixed-temperature sensing shall be independent of rate-ofrise sensing and shall be settable at the FACP to operate at 135 or 155 deg F (57 or 68 deg C).
 - c. Provide multiple levels of detection sensitivity for each sensor.
- B. Photoelectric Smoke Detectors:
 - 1. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.
- C. Ionization Smoke Detector:
 - 1. Sensor: Responsive to both visible and invisible products of combustion. Self-compensating for changes in environmental conditions.
 - Detector Sensitivity: Between 0.5 and 1.7 percent/foot (0.0016 and 0.0056 percent/mm) smoke obscuration when tested according to UL 268A.
- D. Beam-Type Smoke Detector: Each detector shall consist of a separate transmitter and receiver, and shall have the following features:

- 1. UL 268 listed, operating at 24-V dc, nominal.
- 2. Adjustable Sensitivity: At least six sensitivity levels, settable at the receiver, measured as percent of obscuration.
- 3. Two selectable alarm delay settings, allowing each to be associated with a corresponding sensitivity.
- 4. Trouble signal delay, fixed at 20 seconds.
- 5. Separate Color-Coded LEDs: Indicate normal, alarm, and trouble status with remote indicator panels.
- E. Remote Air-Sampling Detector System: Includes air-sampling pipe network, a laser-based photoelectric detector, a sample transport fan, and a control unit.
 - 1. UL 268 listed, operating at 24-V dc, nominal.
 - 2. Pipe Network: Electrical metallic tubing connects control unit with designated sampling holes.
 - 3. Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of three preset values.
 - 4. Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 0.05-inch wg (12.5 Pa) at all sampling ports.
 - 5. Control Unit: Single or multizone unit as indicated. Provides same system power supply, supervision, and alarm features as specified for the central FACP plus separate trouble indication for airflow and detector problems.
 - 6. Signals to the Central FACP: Any type of local system trouble is reported to the central FACP as a composite "trouble" signal. Alarms on each system zone are individually reported to the central FACP as separately identified zones.
- F. Duct Smoke Detectors:
 - 1. Photoelectric Smoke Detectors:
 - a. Sensor: LED or infrared light source with matching siliconcell receiver.
 - b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.
 - 2. Ionization Smoke Detectors:
 - a. Sensor: Responsive to both visible and invisible products of combustion. Self-compensating for changes in environmental conditions.
 - b. Detector Sensitivity: Between 0.5 and 1.7 percent/foot (0.0016 and 0.0056 percent/mm) smoke obscuration when tested according to UL 268A.
 - 3. UL 268A listed, operating at 24-V dc, nominal.
 - 4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 - 5. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting

directly to the air duct. Provide terminals in the fixed base for connection to building wiring.

- a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.
- 6. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
- 7. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status. Provide remote status and alarm indicator and test station where indicated.
- 8. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
- 9. Each sensor shall have multiple levels of detection sensitivity.
- 10. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
- 11. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.5 NONSYSTEM SMOKE DETECTORS

- A. Single-Station Smoke Detectors:
 - 1. UL 217 listed, suitable for NFPA 101, Section 9.6.2.10 occupancies, operating at 120-V ac, with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device.
 - 2. Auxiliary Relays: One Form A and 1 form C, both rated at 0.5 A.
 - Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.
 - 4. Visible Notification Appliance: 177 candela strobe.
 - 5. Heat sensor, 135 deg F (57 deg C) combination rate-of-rise and fixed temperature.
 - 6. Test Switch: Push-to-test, simulates smoke at rated obscuration.
 - 7. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
 - 8. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 9. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 - 10. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
- B. Single-Station Duct Detectors:
 - 1. UL 268A listed, operating at 120-V ac.

- 2. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - a. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.
- 3. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.
 - a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.
- 4. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
- 5. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status. Provide remote status and alarm indicator and test station where indicated.
- 6. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
- 7. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

- A. General: UL 521 listed.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or rate-of-rise of temperature that exceeds 15 deg F (8 deg C) per minute, unless otherwise indicated.
 - 1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).
 - 1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
- D. Continuous Linear Heat-Detector System: Consists of detector cable and control unit.
 - 1. Detector Cable: Rated detection temperature 155 deg F (68 deg C). Listed for "regular" service and a standard environment.

Cable includes two steel actuator wires twisted together with spring pressure, wrapped with protective tape, and finished with PVC outer sheath. Each actuator wire is insulated with heatsensitive material that reacts with heat to allow the cable twist pressure to short circuit wires at the location of elevated temperature.

- 2. Control Unit: Two-zone or multizone unit as indicated. Provides same system power supply, supervision, and alarm features as specified for the central FACP.
- 3. Signals to the Central FACP: Any type of local system trouble is reported to the central FACP as a composite "trouble" signal. Alarms on each detection zone are individually reported to the central FACP as separately identified zones.
- 4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.7 FLAME DETECTORS

- A. Ultraviolet type with solid-state amplifier-switching circuit set for 10-second delay, unless otherwise indicated.
 - 1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.8 NOTIFICATION APPLIANCES

- A. Description: Equipped for mounting as indicated and with screw terminals for system connections.
 - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
- B. Bells: Electric-vibrating, 24-V dc, under-dome type; with provision for housing the operating mechanism behind the bell. Bells shall produce a sound-pressure level of 94 dBA, measured 10 feet (3 m) from the bell. 10-inch (254-mm) size, unless otherwise indicated. Bells are weatherproof where indicated.
- C. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.
- D. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.
- E. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn.
- F. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum

faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

- 1. Rated Light Output: 75 candela.
- 2. Strobe Leads: Factory connected to screw terminals.

G. Voice/Tone Speakers:

- 1. UL 1480 listed.
- 2. High-Range Units: Rated 2 to 15 W.
- 3. Low-Range Units: Rated 1 to 2 W.
- 4. Mounting: Flush, semirecessed, or surface mounted; bidirectional as indicated.
- 5. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.

2.9 SPRINKLER SYSTEM REMOTE INDICATORS

A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.10 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.
 - Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
 - 2. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
 - 3. Rating: 24-V ac or dc.
 - 4. Rating: 120-V ac.
- B. Material and Finish: Match door hardware.

2.11 REMOTE ANNUNCIATOR

- A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Flush cabinet, NEMA 250, Class 1.
- B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LEDs permit acknowledging,

silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

2.12 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.
- B. Integral Relay: Capable of providing a direct signal to the elevator controller to initiate elevator recall, and to a circuit-breaker shunt trip for power shutdown.

2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Listed and labeled according to UL 632.
- B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising 2 lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.
- C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.
- D. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.14 SYSTEM PRINTER

A. Listed and labeled as an integral part of the fire alarm system.

2.15 WIRE AND CABLE

- A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.
 - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.

- C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Line-Voltage Circuits: No. 12 AWG, minimum.
 - 2. Multiconductor Armored Cable: NFPA 70 Type MC, copper conductors, TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, UL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.
- PART 3 EXECUTION
- 3.1 EQUIPMENT INSTALLATION
 - A. Smoke or Heat Detector Spacing:
 - 1. Smooth ceiling spacing shall not exceed 30 feet (9 m).
 - 2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
 - 3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.
 - B. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
 - C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct.
 - D. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
 - E. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
 - F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
 - G. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
 - H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling.
 - I. Device Location-Indicating Lights: Locate in public space near the device they monitor.
 - J. FACP: Surface mount with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

- K. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.
- 3.2 WIRING INSTALLATION
 - A. Install wiring according to the following:
 - 1. NECA 1.
 - 2. TIA/EIA 568-A.
 - B. Wiring Method: Install wiring in metal raceway according to Division 16 Section "Raceways and Boxes."
 - 1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
 - C. Wiring within Enclosures: Separate power-limited and non-powerlimited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressuretype terminal blocks, or plug connectors.
 - D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
 - E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
 - F. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum 1-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
 - G. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 16 Section "Electrical Identification."

- B. Install instructions frame in a location visible from the FACP.
- C. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
 - 2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
 - a. Include the existing system in tests and inspections.
 - 3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
 - 4. Testing: Follow procedure and record results complying with requirements in NFPA 72.
 - a. Detectors that are outside their marked sensitivity range shall be replaced.
 - 5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.
- B. Follow-Up Tests and Inspections: After date of Substantial Completion, test the fire alarm system complying with testing and

visual inspection requirements in NFPA 72. Perform tests and inspections listed for three monthly, and one quarterly, periods.

- C. Semiannual Test and Inspection: Six months after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- D. Annual Test and Inspection: One year after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, semiannual, and annual periods. Use forms developed for initial tests and inspections.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 16721

SECTION 16753

DATA RACEWAY SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. General Summary: Provide conduit and raceway systems for data and communications wiring where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.
- B. Related work: Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
- C. Notify Architect when work is scheduled to be installed. Provide a tentative schedule, divided into phases of installation. Use agreed schedule for installation and for field observation by Architect.

1.2 DEFINITION OF TERMS

- A. The following terms shall apply when referring to data raceway systems:
 - Data system: Refers to the providing of a raceway system(s), equipment backboard, equipment rack(s), power to the equipment and other products as prescribed for use by other trades.
 - 2. Access provider: the operator of any facility that is used to convey telecommunications signals to and from the premises
 - 3. Adapter: a device that enables any or all of the following: different sizes or types of plugs to mate with one another or to fit into a telecommunications outlet; the rearrangement of leads; large cables with numerous wires to fan out into smaller groups of wires; and interconnection between cables.
 - 4. Attenuation: the decrease in magnitude of transmission signal strength between points, expressed in dB as the ratio of output to input signal level.
 - 5. Backbone: a facility, such as a pathway, cable or conductor, between telecommunications rooms or floor distribution terminals, entrance facilities, and the equipment rooms within or between buildings.
 - 6. Cable: an assembly of one or more insulated conductors or optical fibers within an enveloping sheath.
 - Cable run: a length of installed media, which may include other components along its path.
 - 8. Cable sheath: a covering over the an optical fiber or conductor assembly that may include one or more metallic or petroleum-based reinforcing member.
 - 9. Channel: the end-to-end transmission path between two points at which application-specific equipment is connected.
 - 10. Connecting hardware: a device providing mechanical cable terminations
 - 11. Cross-connect: a facility enabling the termination of cable elements and their interconnection or cross-connection.
 - 12. Data: any electronically encoded information, including, but not limited to, internet traffic, computer data traffic, voice signals and any other electronic communications

- End user: the user of the premises cabling system, or the end user who receives or sends data across the premises cabling system
- 14. Entrance facility: an entrance to a building for both public and private network service cables (including wireless) including the entrance point of the building and continuing to the entrance room or space.
- 15. Entrance point: the point of emergence for telecommunications cabling through an exterior wall, a floor or from a conduit.
- 16. Entrance room: a space in which the joining of inter or intra building telecommunications facilities
- 17. Equipment room: (see entrance room) a centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect.
- Horizontal cabling: the cabling between and including the telecommunications outlet/connector and the horizontal crossconnect
- 19. Horizontal cross-connect: a cross-connect of horizontal cabling to other cabling
- 20. Intermediate cross-connect: a cross-connect between the first level and second level backbone cabling
- 21. Main cross-connect: a cross-connect for first level backbone cables, entrance cables and equipment cables
- 22. Outlet/connector: a connecting device in the work area on which horizontal cable or outlet cable terminates
- 23. Patch cord: a length of cord with a plug on one or both ends
- 24. Patch panel: a connecting hardware system that facilities cable termination and cabling administration using patch cords
- 25. Plenum: a compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system; also used to describe cabling rated as safe to run through compartments or chambers to which one or more air ducts are connected and that form part of the air distribution system.
- 26. Star topology: a topology in which telecommunications cables are distributed from a central point.
- 27. Telecommunications: any transmission, emission, and reception of signs, signals, writings, images and sounds that is information of any nature by cable, radio, optical or other electromagnetic or optical systems.
- 28. Terminal: a point at which information may enter or leave a communications network; the input-output associated equipment; and a device by means of which wires may be connected to each other.
- 29. Wire: an individually insulated solid or stranded metallic conductor.
- 30. Data Raceway System: including, but not limited to, any necessary hardware, such as conduit, connectors, braces, terminators, caps, converters, tools and expertise necessary to provide a reliable, safe and sound system for carrying data wiring, as compliant with all applicable laws of governmental agencies having jurisdiction over said work, and with the latest edition of the National Electrical Code, ANSI/TIA/EIA-569-A standard (Commercial Building Standard for Telecommunication Pathways and Spaces) and its addenda and TIA/EIA-568-B standard (Commercial Building Telecommunications Cabling Standard) and its addenda, where it is not in conflict with those laws.

1.3 SUBMITTALS

- A. Submittals Process: Comply with pertinent provisions of Section 01340.
- B. Product data: Within 60 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Materials list of items proposed to be provided under this Section.
 - 2. Shop Drawings showing all details of fabrication, installation, and anchorage of the work of this Section, and its interface with the work of other trades.
- C. Drawings and Specifications: The contract drawings and these specifications shall be considered as complimentary each to the other. What is called for by one shall be considered binding as if called for by both. Where conflicts occur, secure clarification from the Architect/Engineer prior to submitting bids; otherwise, provide for the more costly quality or quantity. The drawings are diagrammatical and dimension figures should be followed in preference to scaling; verify dimensions with the architectural drawings and with field conditions.

1.4 QUALITY ASSURANCE

- A. Workforce: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Experience: Use a subcontractor having not less than five years successful experience in installation of similar products, as approved by the Architect.
- C. Quality of work: All work shall be executed in a workmanlike manner so as to insure a high quality job and to present a neat and mechanical appearance when completed. All materials used shall be new and UL approved for their intended use where such standards have been established.
- D. Applicable Standards: Work included in this section shall comply with all applicable laws of governmental agencies having jurisdiction over said work, and with the latest edition of the National Electrical Code, ANSI/TIA/EIA-569-A standard (Commercial Building Standard for Telecommunication Pathways and Spaces) and its addendums and TIA/EIA-568-B standard (Commercial Building Telecommunications Cabling Standard) and its addendums, where it is not in conflict with those laws.
- E. Site Conditions: Before beginning work the contractor or subcontractor shall visit the project site and ascertain all existing conditions. Adjustment to the work made necessary by actual field conditions shall be made at no additional cost.

F. Handle conduit, connectors, terminators, caps and other raceway system components with great care to prevent undesired bending, end damage and scoring the finish. Store conduit, connectors, terminators, caps and other raceway system components inside and protect from harsh environmental elements. When necessary to store outdoors, elevate the components well above grade and enclose with durable, watertight wrapping.

1.5 COORDINATION WITH OTHER TRADES

A. Coordinate the work in this section so as to conform to the progress of the work of the other trades. Phasing of the work shall be done as soon as possible with the entire installation compiled as soon as the condition of the building permits. As well, review the equipment submittals of all other trades and any Owner-furnished equipment for physical connection requirements, maximum bend radius, minimum distance between electrical and data wiring, electrical voltage, phase, wiring and load characteristics and wiring details.

PART 2 - PRODUCT/MATERIAL/MANUFACTURER DESCRIPTION

2.1 GENERAL

- A. All materials are to be new and of the type and quality specified. Materials must be delivered by labeled, unopened containers. All electrical products must bear the U.L. label.
- 2.02 CONDUITS
 - A. Comply with specifications as set out in Section 16130, Raceways & Boxes.
 - B. Minimum trade size is 3/4" size conduit.
 - C. Minimum bend radius of the conduit shall be no more than the lesser of ten times the diameter of the conduit or the minimum bend radius of the cable or transmission medium carried.
 - D. Conduit will be of one of the following types and from one of the following manufacturers:
 - 1. Electrical Metallic Tubing: shall be galvanized with compression type fittings in damp or wet locations and steel setscrew type fittings in dry locations; Pittsburgh, Republic or equal type conduit is required.
 - 2. Flexible Steel: shall be galvanized with set screw fittings.
 - 3. Liquid-Tight Flexible Steel: Shall have a galvanized steel core covered by a liquid-tight PVC jacket and compression type liquid-type fittings; Anaconda or equal type is required.
 - 4. Rigid Aluminum Conduit: Shall be heavy-wall type with threaded fittings (not allowed in contact with concrete).
 - 5. Rigid Steel Conduit, Intermediate Grade Conduit: Shall be galvanized with threaded fittings; Pittsburgh, Republic or equal type conduit is required.

- E. Where substitution of required type is to be used, substitutes must be of the same style and/or quality level, as to be determined by the Architect. Substitutions should be submitted in accordance with Section 01630.
- 2.3 EQUIPMENT BACKBOARDS
 - A. Provide 3/4" thick American Plywood Association A/D grade plywood, treated with a fire retardant and two coats of light grey paint.
 - B. Backboard shall be started 6" above finished floor and extended 8'6" above finished floor, unless otherwise specified.
 - C. The backboard shall cover all walls of the equipment room or closet, unless otherwise specified.

2.4 PULL TAPE

- A. Provide a pull tape in each empty conduit for use by others. Pull tapes shall have a minimum tensile strength of 130 pounds.
- B. Carlon Part No. TL38203 (5/8", 1800-pound tensile strength) is required, or equivalent when approved by the Architect in accordance with Section 01630.
- C. A "pull line," or rope-like pull tape may be approved by the Architect if it meets or exceeds the standards set forth above.

PART 3 - EXECUTION

3.01 PROJECT CONDITIONS

- A. Coordinate with the data system installer and data system manufacturers as directed by the Owner, Architect, Data and Telecommunications Installer and/or Engineer.
- B. Coordinate mounting and connection details of equipment prior to equipment and electrical rough in. Provide sketches of these layouts as per shop drawing requirements, in compliance with pertinent provisions of Section 01340.
- C. Install products as per Drawings and these specifications.
- D. Provide for maintenance of this work for one year following final approval by governing agencies. Maintenance includes all work required in manufacturer's instructions such as inspection, adjustment, repair and replacement of parts as required.
- E. After installation, inspect all work for improper installation or damage.
- F. Operating fixtures must perform smoothly. Repair or replace any defective work. Repair work shall be undetectable. Redo repairs if work is still defective, as directed by the Architect or governing regulatory agency.
- G. Clean the work area and remove all scrap and excess materials from the site.
- 3.02 INSTALLATION CONDITIONS
 - A. Coated rigid steel or heavy-wall: Rigid steel conduit.
 - B. Slab on grade and areas subject to moisture: Rigid steel conduit.
 - C. Poured concrete and slabs other than on grade: Rigid steel or intermediate grade conduit.
 - D. Overhead and in wall cavities in dry locations: Rigid steel, intermediate grade, electrical metallic tubing or rigid aluminum conduit.
 - E. Final connections to end data outlet boxes: Flexible steel conduit (6'-0" maximum).
 - F. Exposed conduit in areas subject to physical damage or harsh indoor environmental factors: Rigid steel or intermediate grade conduit.
 - G. When possible, conduit shall be colored orange. If conduit, such as rigid steel or other metal-based conduits, the conduit shall be marked with fluorescent orange spray paint at an interval no less than every three feet. Cap terminators for conduit shall be either orange or marked with orange fluorescent spray paint. Other equipment not available in orange shall be marked with orange fluorescent spray paint as to indicate its function.
 - H. Other connections, including endpoint connections to the entrance facility, entrance room, horizontal cross connect location, outlet/connector, intermediate cross connect location, terminal or premises endpoint for a cable run not exposed to harsh environmental conditions: Electrical metallic tubing, using compression type fittings or intermediate grade conduit.
 - Outlet boxes shall be double gang plastic boxes with plaster rings as appropriate for the finished surface, regardless of the number of outlets terminating in the box. Double gang boxes are used to preserve proper bend radius for telecommunications cabling.
 - J. Outlet boxes shall be manufactured by Carlon (Model No. A52151D), or other manufacturer and model number as approved according to Section 01630 and Section 01340.
 - K. Plaster rings shall be manufactured by Carlon (Model No. A410, A411, A412, A413, A414, A420, A421 or A422) as necessary for wall finish and number of outlets.
 - L. No communications outlet box may share the same outlet box as any electrical system.
 - M. Plaster rings shall allow for the placement of a Decora-style faceplate.

- N. Outlet locations shown on the drawings are approximate unless a dimensioned location is specified. Obtain Architect's approval before relocating any outlet due to conflicts.
- O. Outlet boxes shall be installed at height above finished floor as specified on the dimensioned drawings. Otherwise, the outlet shall be installed 18" above finished floor or match the power outlet height.
- P. Every precaution should be taken to protect on site employees, the building, equipment and future occupants.

3.03 INSTALLATION EXECUTION

- A. General: Conduit is to be installed concealed except in equipment rooms and where exposed runs are specifically indicated. Exposed conduits shall be installed parallel with or at right angles to walls, ceilings, structural members, etc. The conduit layout shown on the drawings is diagrammatical only and must be adjusted for actual conditions. Offsets are not shown and must be furnished as required. Keep conduit runs at least 12 inches away from parallel runs of flues, team pipes and other heat producing sources. Conduit sizes shall not be smaller than shown on the drawings and shall comply with Chapter 9 of the NEC where no size is indicated. The minimum trade size shall be 3/4". Conduit carrying any data wiring that crosses over fluorescent lighting fixtures must run at a ninety degree angle to the fixture and must not run parallel to the fixture except where placed six feet away. Conduit carrying any data wiring that crosses over other electrical wiring, exposed or in conduits, must run at a ninety degree angle to the wire or conduit and must not run parallel to the wire or conduit except where placed four feet away for 110V or 120V lines, and six feet for 220V.
- B. Support: All conduits shall be securely fastened and supported within three feet of each outlet box, junction box, pull box, cabinet, termination, fitting, and other conduit end points and at intervals not exceeding 8' between using a clamp, or when PVC conduit is used, a plastic tie. Conduit shall not be welded nor tied with metallic wires.
- C. Underground: Where rigid steel conduit is installed underground, the conduit and couplings shall be provided with a factory applied PVC coating or shall be painted with two coats of asphaltum paint. If plastic conduit is used for below ground runs the turn up through the floor shall be made with a rigid steel elbow. Plastic conduit used for underground service entrance shall be encased in two inches of concrete minimum. All runs of plastic conduit underground shall be provided with a properly sized ground wire. Underground conduit shall be a minimum of 2" in diameter. Underground conduit shall also contain two runs of pull line or pull tape whether empty or not as specified in this section.
- D. In Slab: The overall diameter of any conduit installed in a slab shall not exceed 1/3 the slab thickness. Run the conduit in the center of the slab and route to avoid displacing reinforcing steel.

- E. Conduit Care: Conduit ends shall be cut square, reamed smooth and fully inserted into fittings. Crushed, deformed, nicked or conduit that otherwise would allow for environmental elements to enter the conduit shall not be installed. Where damage occurs after installation, the damaged conduit is to be replaced at the contractors cost. Cap conduit ends with watertight plastic caps or plugs during construction to keep out debris. Maintain the integrity and cleanliness of the conduit's interior throughout the construction process until such time that wiring is to be pulled and conduit is to be terminated. Taping conduit ends is not acceptable. Failure to comply could result in Architect ordering replacement of said conduit at contractor's expense.
- F. Bushings and Grommets: Where raceway is terminated not in an enclosure, such as at a backboard or in a furred space, provide insulated throat bushings. Field-inserted throats are not acceptable.
- G. Conduit Seals: Where conduit passes through a wall, floor or partition that is fire rated, the conduit and its fittings shall meet or exceed fire ratings for walls the conduit passes through, and be U.L. labeled to match wall/barrier fire rating, but not less than 3 hours. The conduit shall have a flanged fitting to provide both fire and smoke stopping. The conduit and its fittings shall conform to ASTM E-119 fire endurance and hose stream criterion. All conduit runs that extend from the interior to the exterior of the building shall be sealed to prevent the circulation of air without damaging the conduit or cabling inside the conduit.
- H. Conduit runs: Conduit should be grouped into parallel runs where practical. Where two or more conduits are run parallel and adjacent they shall be installed on a multiple conduit support channel, or be securely fastened together and then fastened using a multi-conduit clamp or brace. Conduit concealed above a lay-in ceiling shall be supported independent of the ceiling construction with clearance to allow easy removal of ceiling panels and light fixtures. Where pull boxes are placed above lay-in ceilings.
- I. Below-grade runs: Use a thru wall waterproof seal on each conduit that penetrates a wall at or below grade level.
- J. Conduits shall be completely continuous from outlet to outlet, from outlet to cabinet, junction box and pull box. They shall enter and be secured to all boxes and other terminating locations in such a manner that each system will be continuous from service to all outlets. All conduit runs from cabinets and junction boxes shall terminate in approved outlet boxes or conduit fittings.
- K. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected. Failure to examine and/or correct existing conditions will not relieve the contractor of responsibility for the proper operation of this work nor be the basis for a claim for additional compensation by the Owner. Install the work of this section in strict accordance with manufacturer's written

instructions, the approved submittals, and shop drawings.

- L. Coordinate with other trades to assure proper and adequate provisions in the work of those trades for interface with the work of this section.
- M. Install each item in its proper location, fire-caulked in all areas where required by the Code, firmly anchored into position, level, and plumb, and in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 16760

AUDIO/VISUAL/TELECOMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Items in this section shall apply to all sections regarding television signal distribuion, closed circuit television, background music system, audio/visual components of the meeting room and other video, audio and computer data delivery systems.
- B. All materials and equipment specified herein have been determined to provide an overall physical appearance and background of proven operation desired by the Owner, and therefore, to establish a standard of quality required for this project. If equipment or material other than that specified is proposed to be furnished, this Contractor shall be required to furnish the Architect with such samples as he reuires, the same to be submitted by the Architect to an independent testing laboratory selected by the Architect for tests to determine the actual equality of the propsed substitute items. The Architect reserves the right to examine, and where necessary, have additional tests made of the actual equipment delivered and installed on the jobsite to insure that the installed equipment is equal in fact to that specified. The Architect's decision, based on these test and other factors, shall be final.
- C. At the time of project closeout, subit a minimum of four sets of each product manual.
- D. Site Conditions: Before beginning work the contractor or sub-contractor shall visit the project site and ascertain all existing conditions. Adjustment to the work made necessary by actual field conditions shall be made at no additional cost.
- 1.2 SCOPE OF WORK
 - A. Work under this contract shall include the furnishing of all labor, materials, tools, transportation services, supervision, and other related costs necessary to complete the installation of the audio, video and other systems as directed by this document, as illustrated on the accompanying documents or as directed by the Architect. Work is comprised of, but not limited to, the following principal items:
 - 1. Sound reinforcement system
 - 2. Portable audio and video equipment systems and accessories
 - 3. Audio cables, outlets, relays, connections and wiring
 - 4. Custom panels and equipment as required.
 - B. All conduits, junction boxes (except as noted otherwise), power wire and power circuits, etc. for the aforementioned systems are provided under Section 16753. This does not, however, relieve the contractor from the responsibility for complete, working, overall systems and coordination with other trades. Failure to do so shall not be reason for addition to contract amount because of omission or error in installing conduits or boxes.

- C. Provide all necessary patch cables, power cables, power adaptors, cable, connecting hardware, cross-connects, intermediate cross-connects, outlets/connectors, patch panels, terminals and or wires that make the system operate.
- PART 2 PRODUCTS/MATERIALS/MANUFACTURER DESCRIPTIONS
- 2.1 TELECOMMUNICATIONS AND DATA CABLING
 - A. Where horizontal telecommunications cable is specified for telephone or other electronic communications, unless otherwise specified, contractor should provide cable meeting or exceeding the following standards:
 - Cable shall be of Category 6 (CAT 6) grade, as specified by TIA/EIA-568-B.2-1, specifying CAT 6 grade cabling. Cable shall be 4-pair 100 ohm Unshielded Twisted Pair (UTP).
 - 2. The total horizontal distance of the cable path from the outlet to the telecommunications room shall not exceed 275 feet, including termination loss and slack.
 - 3. For telephone purposes, cable color shall be blue.
 - 4. Cable shall have an internal pull thread for ease in installation.
 - 5. Cable shall have an internal plastic core that separates pairs into a four quadrant pattern.
 - 6. Cable shall be manufactured by AMP Netconnect (Part No. 1499038-6 for blue telephone systems cabling), or Belden (Part No. 7881A-6 for blue telephone systems).
 - B. Where horizontal telecommunications cable is specified for internet or computer data communications, unless otherwise specified, contractor should provide cable meeting or exceeding the following standards:
 - Cable shall be of Category 6 (CAT 6) grade, as specified by TIA/EIA-568-B.2-1, specifying CAT 6 grade cabling. Cable shall be 4-pair 100ohm Unshielded Twisted Pair (UTP).
 - 2. The total horizontal distance of the cable path from the outlet to the telecommunications room shall not exceed 275 feet, including termination loss and slack.
 - 3. For data grade, cable shall be yellow.
 - 4. Cable shall have an internal pull thread for ease in installation.
 - 5. Cable shall have an internal plastic core that separates pairs into a four quadrant pattern.
 - Cable shall be manufactured by AMP Netconnect (Part No. 1499038-8 for yellow data cabling), or Belden (Part No. 7881A-4 for yellow data systems).
 - C. Where telecommunications backbone cabling from an intermediate crossconnect or main cross-connect is specified for telephone or other electronic communications, not including cabling for internet or computer data communications, unless otherwise specified, contractor should provide cable meeting or exceeding the following standards:
 - Because of the limited amount of data transmitted over a telephone communications line, cable shall be of Category 5e (CAT 5e) grade, as specified by TIA/EIA-568-B.2, specifying CAT 5e grade cabling. Cable shall be 25-pair 100 ohm Unshielded Twisted Pair (UTP).

- 2. The total vertical distance of the cable path from a intermediate cross-connect to the telecommunications room shall not exceed 275 feet, including termination loss and slack.
- 3. For telephone purposes, cable shall be blue.
- 4. Cable shall have an internal pull thread for ease in installation.
- 5. Cable shall be manufactured by AMP Netconnect (Part No. 1499418-3 for blue telephone cabling).
- D. Where data backbone cabling from an intermediate cross-connect or maincross connect is specified for internet or computer data communications, unless otherwise specified, contractor should provide cable meeting or exceeding the following standards:
 - Cable shall be of Category 6 (CAT 6) grade, as specified by TIA/EIA-568-B.2-1, specifying CAT 6 grade cabling. Cable shall be 4-pair 100 ohm Unshielded Twisted Pair (UTP).
 - 2. The total vertical distance of the cable path from an intermediate cross-connect to the telecommunications room shall not exceed 275 feet, including termination loss and slack.
 - 3. For data purposes, cable shall be yellow.
 - 4. Cable shall have an internal pull thread for ease in installation.
 - 5. Cable shall have an internal plastic core that separates pairs into a four quadrant pattern.
 - Cable shall be manufactured by AMP Netconnect (Part No. 1499038-8 for yellow data cabling), or Belden (Part No. 7881A-4 for yellow data systems).
- E. Under no circumstances shall cable or connecting equipment, including but not limited to punch blocks, patch panels, outlets, and connectors, be installed that is not consistent with the lowest common denominator of cabling grade from end-point to end-point, as in from outlet to telecommunications room. The minimum grade to be installed is CAT 5e for telephone backbone cabling and CAT 6 for all other data and telecommunications purposes, unless otherwise specified.

2.2 VIDEO/CCTV CABLING

- A. Where cabling for television signal distribution is specified for closed circuit television or cable television distribution wiring, unless otherwise specified, contractor should provide cable meeting or exceeding the following standards:
 - Cable shall be of RG-6/U grade. Cable shall have a core size of 18 AWG, as specified by the American Wire Gauge Standard for cable sizes. The core of said cable shall be solid-core, bare copper, with a diameter of 0.040". The core shall be surrounded by a gas-injected foam HDPE insulation. The foam core insulation shall be covered by a tinned copper braid shield. The entire cabling shall be encased in a PVC jacket.
 - 2. Cable shall be 75 ohms nominal impedance.
 - 3. Cable shall be sweep tested by the manufacturer before shipping and certified by the test as such.
 - 4. No discontinuities shall exist from 20 to 890 MHz on the cable.
 - 5. The total vertical distance of the cable path from the farthest outlet termination to the telecommunications room shall be so as to provide no more than 43dB signal to noise ratio, including termination signal loss and slack.

- 6. Cable shall be black.
- 7. Cable shall be UL listed.
- 8. No cable which shows bruises or shipping damages shall be installed in the system, nor shall any splices or connectors be installed in the conduit system.
- 9. Cable shall be manufactured by Belden (Part No. 9248) or West Penn (Part No. 815).

2.3 AUDIO/VIDEO/MONITOR CONNECTING CABLES

- A. Where cabling for connecting hardware related to audio/video/monitor distribution, unless otherwise specified, contractor should provide cable meeting or exceeding the following standards:
 - 1. Cables shall be supplied as approved by manufacturer of equipment to be connected.
 - 2. Cables shall have connectors exactly matching those on each endpoint of the cable. No splices or connector changers will be allowed.
 - 3. Cables shall not allow for interference from surrounding electrical and data cabling.
- PART 3 EXECUTION

3.1 GENERAL CABLE INSTALLATION

- A. Contractor shall coordinate work with other trades.
- B. The Architect shall have access to all construction sites at all times for purposes of inspecting communications facilities and equipment and for direction on how to properly install all equipment specified in this and related Sections. To enable these inspections, contractors must:
 - 1. Provide a progress schedule with the installation of components in each individual section.
 - 2. Notify the Architect as per Section 01630 in writing of any change in mechanical drawings and specifications affecting systems covered under this specification.
 - 3. Provide proper access for facilities and inspections.
 - 4. Notify the Architect when the work is ready for inspection.
- C. The contractor shall provide a final checkout certification letter and inspection reports to the Architect on all aspects covered under this specification as per Section 01630. All systems installed by outside vendors will be required to provide a three year vendor warranty against mechanical failure due to faulty workmanship, as well as a 15 year performance warranty.
- D. The contractor shall submit to the Architect a detailed test procedure to be used for every section covered under this Section as per Section 01630. All cables shall be tested for maximum allowable length, attenuation, impedance, ground shorts, continuity of communications conductors, shields, NEXT and crosstalk.
- E. Cable shall be contained in conduit where subject to vandalism or physical or environmental abuse, compliant with Section 16753.
- F. All cabling shall be tested for compliance to meet ANSI/TIA/EIA standards for the cable level installed. A copy of the final test

results shall be delivered to the Architect in both written and electronic form within 10 days of the project turnover date. In the case an ANSI/TIA/EIA compliant code is not available for cabling grade, the Architect may visually inspect said system to insure compliance with general guidelines specified in this section.

- G. Take such precautions as are necessary to prevent and guard against electromagnetic and electrostatic hum on audio systems. Take such precautions as are necessary to prevent and guard against electromagnetic and electrostatic artifacts on video systems.
- H. Where cabling for television signal distribution is specified for closed circuit television or cable television distribution wiring above drop tile ceilings, unless otherwise specified, shall be exposed but strapped to structure above ceiling on a minimum of three foot centers. Cable shall be taut and shall not interfere with tile removal.
- Upon completion, copies of as built drawings related to communications work and all test results shall be submitted to the Architect for final approval and acceptance and made part of the document. The contractor shall guarantee 100 percent good pairs on all cables.
- J. Contractor will perform necessary testing before accepting a job. Failure during testing will result in re-pulling cables at contractor's expense.
- K. A high degree of excellence in installation and techniques and overall system operation is expected, therefore all work must be performed by trained technicians on the staff of the contractor and shall have direct control of the installation and maintenance personnel assigned to this work.
- L. Upon completion of the equipment installation, it shall be the responsibility of the contractor to perform the necessary mixing, matching, balancing and impedance matching of all signals for proper signal distribution.
- M. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected. Failure to examine and/or correct existing conditions will not relieve the contractor of responsibility for the proper operation of this work nor be the basis for a claim for additional compensation by the Owner. Install the work of this section in strict accordance with manufacturer's written instructions, the approved submittals, and shop drawings.
- N. Coordinate with other trades to assure proper and adequate provisions in the work of those trades for interface with the work of this section.
- O. Install each item in its proper location, fire-caulked in all areas where required by the Electrical Code, firmly anchored into position, level, and plumb, and in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 16765

TELEVISION DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. General Summary: Furnish and install a complete Television Distribution System including wiring and TV distribution equipment.
- B. Related work: Documents affecting work of this section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these specifications.
- C. Work Schedule: Notify Architect when work is scheduled to be installed. Provide a tentative schedule, divided into phases of installation. Use agreed schedule for installation and for field observation by Architect.
- D. Sections Referenced: Follow guidelines outlined in Section 16753, 16760.
- 1.2 SCOPE OF WORK
 - A. Provide a complete and operational system for the pick-up, amplification and reproduction of available cable channels.
 - B. The system shall be designed for a 43dB signal to noise ratio and shall provide a signal level with a minimum of +5 dBmv and a maximum of 20 dBmv at each outlet.

1.3 SUBMITTALS

- A. Submittals Process: Comply with pertinent provisions of Section 01340.
- B. Product data: Within 60 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Materials list of items proposed to be provided under this Section.
 - 2. Shop Drawings showing all details of fabrication, installation, and anchorage of the work of this Section, and its interface with the work of other trades.
- C. Drawings and Specifications: The contract drawings and these specifications shall be considered as complimentary each to the other. What is called for by one shall be considered binding as if called for by both. Where conflicts occur, secure clarification from the Architect/Engineer prior to submitting bids; otherwise, provide for the more costly quality or quantity. The drawings are diagrammatical and dimension figures should be followed in preference to scaling; verify dimensions with the architectural drawings and with field conditions.
- D. As-built drawings shall be provided to the Architect no less than 10 days after the stop of work outlined in this section.

E. A one line drawing of the entire system shall be included in the submittal package showing signal levels of dBmv at the input and output of each device, at the head end, splitters, amplifiers, room outlets, type of cable, and model number of all equipment shall be shown on a one line drawing. Submittals not having this drawing shall be rejected without further review.

1.4 QUALITY ASSURANCE

- A. Workforce: The contractor or an approved sub-contractor shall be an authorized distributor for the equipment supplied under this contract. He shall maintain his own service organization which shall be under his direct control, capable of furnishing service to the owner and provide the warranty as herein specified.
- B. An adequate number of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section should be used.
- C. Experience: Use a subcontractor having not less than five years successful experience in the installation of similar products, as approved by the Architect.
- D. Quality of work: All work shall be executed in a workmanlike manner so as to insure a high quality job and to present a neat and mechanical appearance when completed. All materials used shall be new and UL approved for their intended use where such standards have been established.
- E. Applicable Standards: Work included in this section shall comply with all applicable laws of governmental agencies having jurisdiction over said work, and with the latest edition of the National Electrical Code, ANSI/TIA/EIA-569-A standard (Commercial Building Standard for Telecommunication Pathways and Spaces) and its addendums and TIA/EIA-568-B standard (Commercial Building Telecommunications Cabling Standard) and its addendums, where it is not in conflict with those laws.
- F. Site Conditions: Before submitting a bid the contractor or subcontractor shall visit the project site and ascertain all existing conditions. Adjustment to the work made necessary by actual field conditions shall be made at no additional cost.
- G. Handle cable and components with great care to prevent undesired bending, end damage and scoring the finish. Store cable and components inside and protect from harsh environmental elements.

1.5 COORDINATION WITH OTHER TRADES

- A. Coordinate the work in this section so as to conform to the progress of the work of the other trades. Phasing of the work shall be done as soon as possible with the entire installation completed as soon as the condition of the building permits. As well, review the equipment submittals of all other trades and any Owner-furnished equipment for physical connection requirements, maximum bend radius, minimum distance between electrical and data wiring, electrical voltage, phase, wiring and load characteristics and wiring details.
- PART 2 PRODUCTS

2.1 GENERAL

- A. All Materials are to be new and of the type and quality specified. Materials must be delivered by labeled, unopened containers. All electrical products must bear the U.L. label.
- B. The equipment herein specified is based on equipment manufactured by Blonder-Tongue, Leviton Voice and Data Division or Atlas/Soundolier.
- 2.2 CHANNEL FILTER/CONVERSION FILTER
 - A. Contractor shall provide a system that will allow for the filtering of stations 51-68.
 - B. These channels must be rerouted to consecutive channels above channel 68 for viewing.
 - C. Channels must not exceed the total number of CCTV channels viewable by the in-room televisions.
- 2.3 CHANNEL CONVERTER
 - A. Contractor shall provide a solid state channel converter having 75 ohms coaxial inputs and outputs.
 - B. The local oscillator shall be crystal controlled.
 - C. Conversion shall be from UHF to VHF or VHF to VHF channel respectively with a gain of 14dB.
 - D. The unit shall comply with FCC radiation regulations and be UL listed.
 - E. The unit shall be manufactured by Blonder-Tongue, and be of model MCX series.

2.4 AMPLIFIER

- A. Contractor shall provide a broadband amplifier of the push-pull type.
- B. Output capability shall be at least +49 dBmv with adjustable gain of 51 dBmv down to 41 dBmv through variable attenuator.
- C. Gain and slope controls shall be located on the front panel for easy setup and adjustment.

- D. Two -30 dB back-matched test points shall be provided to permit testing without interruption of service.
- E. The unit shall be manufactured by Blonder-Tongue, and be of model type BIDA550-50. The unit shall also include a BIDA-RA model return amplifier.
- 2.5 CHANNEL REJECT FILTER
 - A. Contractor shall provide a channel reject filter for the purpose of rejecting one low band channel.
 - B. The filter shall provide at least 57 dB of attenuation to the audio and video carriers of the unwanted channel. The filter shall provide less than 2 dB of slope across either of the two adjacent channels with no more than 2 dB of thru loss of the other channels in the 50-300 Mhz range.
 - C. The unit shall be supplied with appropriate associated circuitry to permit reinsertion of a locally originated channel from a crystal-controlled modulator.
 - D. The filter shall permit rejection of one channel and reinsertion of a locally originating channel without visible interference of any other channel.
 - E. The unit shall be manufactured by Blonder-Tongue, and be of model type CEF.
- 2.6 AGILE PROCESSOR
 - A. Contractor shall provide agile processors as required.
 - B. Processors shall be rack-mountable.
 - C. Processors shall be able to convert any sub-channel from T-9 to T-13 or any channel from 2 to 69.
 - D. Processors shall provide synthesized tuning of output in 250 kHz increments to accommodate any traditional broadcast, CATV, HRC, or IRC channel alignment.
 - E. Processor's input impedance shall be 75 ohms and shall incorporate a SAW filter design which provides an adjacent channel rejection.
 - F. A frequency span of 550 MHz at an output level of +60 dBmv shall be provided.
 - E. The processors shall be manufactured by Blonder-Tongue, and be of model type AP-60-550.
- 2.7 HIGH Q TRAPS
 - A. Contractor shall provide traps to be installed where required for the rejection of interfering carriers.

- B. Traps shall have an input and output impedance of 75 ohms and connection shall be made through standard F-style connectors.
- C. The traps shall be manufactured by Blonder-Tongue, and be of model type MWT Series.

2.8 AGILE MODULATOR

- A. Contractor shall provide an audio/video modulator for the insertion of a locally generated channel.
- B. The modulator shall provide synthesized tuning of modulated visual and aural RF carrier output in 250 kHz increments to accommodate any traditional broadcast, CATV, HRC, or IRC channel alignment.
- C. A frequency span of 550 MHz at an output level of +60 dBmv shall be provided.
- D. Frequency changing shall be accomplished by using front panel DIP switches with a setting chart attached to the front cover.
- E. The modulators shall be manufactured by Blonder-Tongue, and be of model type AM-60-550.

2.9 SPLITTER/COMBINER

- A. Contractor shall provide a splitter/combiner.
- B. The splitter/combiner shall be of a hybrid type, having essentially flat response across the frequencies utilized on the system.
- C. The splitter/combiner shall be housed in an environment-proof, radiation-proof housing.
- D. The splitter/combiner shall have F-type fittings.
- E. The modulators shall be manufactured by Blonder-Tongue, and be of model type SUV, MSVM and MLHF series.

2.10 TV TAPOFF

- A. Contractor shall provide TV tap-offs where necessary.
- B. The tap-off shall be of a directional coupler type, mounted in trunkline junction boxes in the ceiling of hallways.
- C. The tap-off shall have a feeder line running from the taps through conduit to outlets in rooms as shown on plans.
- D. The tap-offs shall exhibit five isolation factors and shall have F-type connectors.
- E. The modulators shall be manufactured by Blonder-Tongue, and be of model type SUV, MSVM and MLHF series.

2.11 SELF-TERMINATING OUTLET

- A. Contractor shall provide modules for coaxial cabling media. They shall be individual snap-in style female-to-female bulkhead adapters, and shall fit all other installed telecommunications wall plates, outlets and field-configurable patch panels and patch blocks.
- B. Bulkhead modules shall be available in four colors (ivory, white, grey and black) to match the housings.
- C. Modules shall be UL listed. All plastics used in construction of the module bodies shall be fire-retardant with a UL flammability rating of 94V-0.
- D. A ten foot connecting cable shall be provided for each outlet.
- E. The connectors shall be manufactured by Leviton Voice and Data, and be of model type 41084-FIF.

2.12 TERMINATORS

- A. Contractor shall provide terminating resistors for the purpose of terminating coaxial lines.
- B. Terminators shall be placed on all end branches of the television distribution system.
- C. Terminators shall be products of the manufacturer of the amplifier and/or tap-off units used in this system and shall be approved by the manufacturer for use in the 54 MHz to 890 MHz range with a return loss of 30 dB minimum for VHF and 25 dB for UHF.
- D. The modulators shall be manufactured by Blonder-Tongue, and be of model type FBT series.

2.13 EQUIPMENT HOUSING

- A. Contractor shall provide a wall-mounted equipment cabinet for authorized personnel to gain easy access to components, and provide secure storage against vandalism.
- B. The cabinet shall be constructed of at least 16 gauge cold-rolled steel, heavily reinforced for maximum strength and durability.
- C. Cabinet shall be no more than 45" high and 22" deep with 28-1/8" total panel space.
- D. Cabinets shall be furnished with one left hand door and one right hand door.
- E. The equipment cabinet shall be manufactured by Atlas/Soundolier, and be of model type 300-28.

2.14 TV WALL-MOUNT

- A. Contractor shall provide a wall-mount device for suspending a television from the wall in the fitness center.
- B. The wall-mount shall have jointed arms to allow for 180 degree swing.
- C. The wall-mount shall have a comprehensive cable management system to hide cable(S).
- D. The wall-mount shall accommodate 19"-25" size televisions, handle a maximum load of 88 pounds and a maximum depth of 25-5/8".
- E. The wall-mount shall be manufactured by Pivotelli and be of model type Quartz.
- 2.15 ADD ALTERNATIVE HEARING ASSISTANCE SYSTEM
 - A. Contractor shall provide an alternate hearing assistance system to be connected to the room televisions in ADA allocated guest rooms.
 - B. The hearing assistance system shall operate on VHF frequencies between 72 and 76 MHz.
 - C. The hearing assistance system signal shall be frequency modulated, with a deviation not to exceed 25 kHz. The overall system frequency response should be between 330-8000 Hz, plus 3 dB, with a signal-to-noise ratio of 48 dB un-weighted.
 - D. The hearing assistance system shall be a rack mountable 117VAC powered unit measuring 1-3/4" high by 7-1/4" wide and 6-7/8" deep.
 - E. The hearing assistance system shall have a 5-segment, input level, LED meter with independent controls for line and mic levels. The transmitter shall be equipped with a PL-259 connector on the rear panel for connection to the antenna.
 - F. The hearing assistance system shall receive frequency modulated signals and have an integrated belt clip, with a top-mounted volume control.
 - G. The hearing assistance system shall have a 1/8" combination earphone/power charge jack on the top panel.
 - H. The hearing assistance system shall be manufactured by Telex and consist of model type AAT-1 transmitter and one AAR-10 receiver either tied directly into the television set or a custom built plate on the wall that is wired into the television.

2.16 OTHER MATERIALS

A. All other materials and accessories, not specifically described or called for, but are necessary for a complete finished installation for the work of this section shall be furnished and installed by the Contractor at no additional cost. These materials shall be selected by the Contractor and approved by the Architect.

- B. All selected materials must be approved by the Architect, with information submitted to the Architect as pursuant to Section 01340.
- PART 3 EXECUTION
- 3.01 PROJECT CONDITIONS
 - A. Upon completion, it shall be the responsibility of the Contractor to perform the necessary mixing, matching and balancing of signals for a properly operating system as described here-in.
 - B. A demonstration shall be performed in the presence of an authorized representative of the Architect. The Contractor shall forward a letter stating this has been carried out and name the person(s) in attendance for the demonstration.
 - C. At the time of project closeout, subit a minimum of four sets each product manual.

3.02 EQUIPMENT

- A. Protect finished installation from damage by other trades.
- B. Remove rubbish and left over materials from the site.
- C. Provide one year warranty on the entire system including on site labor during normal working hours at no cost to the Owner for a period of twelve months from the date of acceptance.
- D. Guarantee response to a trouble call within one normal business day after receipt of such call.
- E. Contractor shall provide a written agreement outlining warranty acceptance.

3.03 INSTALLATION

- A. Follow guidelines for Data Raceway System installation, as pursuant to Section 16753.
- B. Follow guidelines for cable securing, installation, and termination, as pursuant to Section 16760.
- C. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected. Failure to examine and/or correct existing conditions will not relieve the contractor of responsibility for the proper operation of this work nor be the basis for a claim for additional compensation by the Owner. Install the work of this section in strict accordance with manufacturer's written instructions, the approved submittals, and shop drawings.

- D. Coordinate with other trades to assure proper and adequate provisions in the work of those trades for interface with the work of this section.
- E. Install each item in its proper location, fire-caulked in all areas where required by the Electrical Code, firmly anchored into position, level, and plumb, and in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 16780

BACKGROUND MUSIC/MUSIC ON HOLD SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. General Summary: Provide a background music and music on hold system for entertainment and a pleasant customer and workplace experience as shown on the Drawings, as specified herein, and as needed for a complete and proper installation. System shall provide background music in Pavilion area, lounges, dining area, retail space, restrooms, and circulation areas, except in the vicinity of telephone and front desk areas, as well as music on hold in coordination with the internal telecommunications system.
- B. Related work: Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
- C. Notify Architect when work is scheduled to be installed. Provide a tentative schedule, divided into phases of installation. Use agreed schedule for installation and for field observation by Architect.
- D. The intent of this specification is to provide a complete and satisfactory background music and music on hold system. The system shall include, but not be limited to, electronics, music source, AM/FM antenna, peripheral devices, conduit, wire, and accessories required to provide a complete and operational system

1.2 SUBMITTALS

- A. Submittals Process: Comply with pertinent provisions of Section 01340.
- B. Product data: Within 60 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Materials list of items proposed to be provided under this Section.
 - 2. Shop Drawings showing all details of fabrication, installation, and anchorage of the work of this Section, and its interface with the work of other trades.
- C. Drawings and Specifications: The contract drawings and these specifications shall be considered as complimentary each to the other. What is called for by one shall be considered binding as if called for by both. Where conflicts occur, secure clarification from the Architect/Engineer prior to submitting bids; otherwise, provide for the more costly quality or quantity. The drawings are diagrammatical and dimension figures should be followed in preference to scaling; verify dimensions with the architectural drawings and with field conditions.

1.3 QUALITY ASSURANCE

A. Workforce: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

- B. Experience: Use a subcontractor having not less than five years successful experience in installation of similar products, as approved by the Architect.
- C. Quality of work: All work shall be executed in a workmanlike manner so as to insure a high quality job and to present a neat and mechanical appearance when completed. All materials used shall be new and UL approved for their intended use where such standards have been established.
- D. Applicable Standards: Work included in this section shall comply with all applicable laws of governmental agencies having jurisdiction over said work, and with the latest edition of the National Electrical Code, ANSI/TIA/EIA-569-A standard (Commercial Building Standard for Telecommunication Pathways and Spaces) and its addendums and TIA/EIA-568-B standard (Commercial Building Telecommunications Cabling Standard) and its addendums, where it is not in conflict with those laws.
- E. Site Conditions: Before beginning work the contractor or sub-contractor shall visit the project site and ascertain all existing conditions. Adjustment to the work made necessary by actual field conditions shall be made at no additional cost.
- F. Handle conduit, connectors, terminators, caps, computer equipment, amplifiers, speakers, music sources and other background music and music on hold system components with great care to prevent undesired bending, damage and scoring the finish. Store conduit, connectors, terminators, caps, computer equipment, amplifiers, speakers, music sources and other background music and music on hold system components inside and protect from harsh environmental elements.
- 1.4 COORDINATION WITH OTHER TRADES
 - A. Coordinate the work in this section so as to conform to the progress of the work of the other trades. Phasing of the work shall be done as soon as possible with the entire installation completed as soon as the condition of the building permits. As well, review the equipment submittals of all other trades and any Owner-furnished equipment for physical connection requirements, maximum bend radius, minimum distance between electrical and data wiring, electrical voltage, phase, wiring and load characteristics, wiring details and impedance matching.
- 1.5 SCOPE OF WORK
 - A. The background music and music on hold system specified herein shall be of a modular design and nature to facilitate both expansion and service and shall be completely of a solid-state design.
 - B. All conduit, equipment and installation materials required to fulfill the above shall be furnished whether or not specified herein or on the drawings, and shall be subject to approval by the Architect as pursuant to Section 01630.
 - C. The installation supervisor shall instruct designated personnel in the correct operation of the system.
 - D. The contractor shall provide two complete sets of the following: Installation drawings, wiring diagrams, instruction manuals, schematic drawings and service manuals upon completion.

- E. The system shall be guaranteed for a period of one year from date of acceptance against defective materials, design and workmanship. Any defective materials shall be replaced at no cost to the owner.
- F. The contractor shall submit to the Architect a detailed test procedure to be used for every section covered under this Section as per Section 01630. All cables shall be tested for electrostatic and electromagnetic hum, and, if such noise is audible, shall be corrected to remove said electrostatic and electromagnetic hum.
- G. The contractor, if requested to do so by the Architect, shall be prepared to show by proof of performance test(s) that the equipment furnished and installed on the job is equal to or exceeds the equipment specifications as listed herein. This proof of performance shall be by actual tests and not by printed technical or sales literature on said products. To this end, the contract shall provide qualified technicians and such test equipment as necessary to perform these tests. The Architect has final approval of tests to be performed to meet these requirements.
- PART 2 PRODUCTS
- 2.1 EQUIPMENT RACK
 - A. Contractor shall provide a sectional wall cabinet constructed of 16gauge CRS.
 - B. Equipment rack shall be bolted for strength. Rack may not be welded.
 - C. Equipment rack shall have a rear section with knockouts at the bottom and the top to allow for cable routing.
 - D. Equipment cabinet shall have a locking door and have bolted hinges, not welded. Lock shall be mounted on the front door and accessible only through a key-type lock.
 - E. The unit shall be manufactured by Atlas/Soundolier, and be of model 300 Series.
- 2.2 POWER AMPLIFIERS
 - A. Contractor shall provide power amplifiers necessary to provide 35 watts of continuous power with no less than 1 percent distortion from 20 to 20 kHz to each area specified in Section 1 of these specifications.
 - B. Power amplifiers shall provide five main inputs, an auxiliary input, and a telephone/pager input.
 - C. Power amplifiers shall have a signal-to-noise ratio greater than 70 dB for auxiliary inputs and telephone/pager inputs.
 - D. Power amplifiers shall have a frequency response from 20 to 20 KHz, plus or minus 1 dB, at 9 dB below rated output per EIA SE-101A specifications.
 - E. Power amplifiers shall provide electronic fold-back and thermal overload self-restoring protection circuits, with 30 dB of muting.
 - F. Power amplifiers shall provide independent input controls for five main

inputs, as well as a power switch, on the front panel.

- G. The unit shall be manufactured by Dukane, and be of model 1A1635.
- 2.3 AREA SPEAKER VOLUME CONTROL
 - A. Contractor shall provide area speaker controls to each area specified in Section 1 of these specifications.
 - B. Area speaker volume controls shall provide control of designated area's speaker(s) volume on 25 or 70 volt speaker distribution lines, controlling up to 35 watts of audio power per area.
 - C. Area speaker volume controls shall accomplish attenuation in 10 steps, including "off".
 - D. Area speaker volume controls shall provide 15 dB of attenuation with a decrease of 1.5 dB per step, except from top setting to next setting with a 3 dB attenuation step.
 - E. Area speaker volume controls shall provide a finish of either satin aluminum or flat plastic, with color to be selected by Architect.
 - F. Area speaker volume controls shall clearly display the current volume setting.
 - G. Area speaker volume control shall fit into a single or dual gang box, 2 1/2'' deep.
 - H. The unit shall be manufactured by Dukane, and be of model 9A1550.
- 2.4 LOUDSPEAKERS
 - A. Contractor shall provide loudspeakers in each area specified in Section 1 of these specifications and as drawn on associated plans.
 - B. Loudspeakers shall be of the recessed type and self-supporting.
 - C. Loudspeakers shall be 8" (20.3 cm), seamless cone type, with a ceramic magnet weighing at least 4.8 ounces (134 g).
 - D. Loudspeakers shall have a frequency response range from 90 to 15,000 Hz, and be of a normal wattage rating of 8-15 watts with a program rating of 20 watts.
 - E. Loudspeakers shall have a voice coil of diameter 3/4" (2 cm) and be of 8 ohms nominal impedance.
 - F. Loudspeakers overall diameter shall be 8 1/32" (20.3 cm) and the speaker depth shall be no more than 2 $3/4"\,.$
 - G. Loudspeakers' components shall be cadmium plated and conform with EIA standards.
 - H. Loudspeakers shall be equipped with a universal matching transformer suitable for use on a 25 volt output line with taps at 1/2, 1 or 2 watts or a 70 volt output line with taps at 1/2, 1, 2 or 4 watts.
 - I. The unit shall be manufactured by Dukane, and be of model 5A606.

PART 3 - EXECUTION

3.1 PROJECT CONDITIONS

- A. Upon completion, it shall be the responsibility of the Contractor to perform the necessary mixing, matching and balancing of signals for a properly operating system as described here-in.
- B. A demonstration shall be performed in the presence of an authorized representative of the Architect. The Contractor shall forward a letter stating this has been carried out and name the person(s) in attendance for the demonstration.
- C. At the time of project closeout, submit a minimum of four sets each product manual.

3.2 EQUIPMENT

- A. Protect finished installation from damage by other trades.
- B. Remove rubbish and left over materials from the site.
- C. Provide one year warranty on the entire system including on site labor during normal working hours at no cost to the Owner for a period of twelve months from the date of acceptance.
- D. Guarantee response to a trouble call within one normal business day after receipt of such call.
- E. Contractor shall provide a written agreement outlining warranty acceptance.
- 3.3 INSTALLATION
 - A. Follow guidelines for Data Raceway System installation, as pursuant to Section 16753.
 - B. Follow guidelines for cable securing, installation, and termination, as pursuant to Section 16760.
 - C. Head-end equipment shall be connected to a separate dedicated branch circuit, maximum 20 amperes. Circuit shall be labeled as "PUBLIC ADDRESS".
 - D. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected. Failure to examine and/or correct existing conditions will not relieve the contractor of responsibility for the proper operation of this work nor be the basis for a claim for additional compensation by the Owner. Install the work of this section in strict accordance with manufacturer's written instructions, the approved submittals, and shop drawings.
 - E. Coordinate with other trades to assure proper and adequate provisions in the work of those trades for interface with the work of this section.

F. Install each item in its proper location, fire-caulked in all areas where required by the Electrical Code, firmly anchored into position, level, and plumb, and in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 16781

TELEVISION ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide television accessories where shown on the drawings, as specified herein, and as needed for a complete and proper installation.
- B. Related work:
 - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
 - Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
 - b. TIA specifications T568B;
 - c. Section 01720: Project Record Documents;
 - d. Section 01730: Operation and Maintenance;
 - e. Section 16753: Data Raceway Systems;
 - f. Section 16760: Audio/Visual/Telecommunications Systems;
 - g. Section 16765: Television Distribution System;
 - h. Section 16780: Background Music/Music On Hold Systems;
 - i. Section 16785: Closed Circuit Television Systems;
 - j. Section 16786: Meeting Room Systems;
 - k. Section 16787: High Speed Internet Access.

1.2 SUBMITTALS

- A. Comply with pertinent provisions of Section 01340.
- B. Product data: Within 35 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Materials list of items proposed to be provided under this Section;
 - 2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
 - 3. Dimensioned drawings as needed to depict the space required for these items, and their interface with the work of other trades.
 - 4. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the Work.

1.3 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section. All telecommunication wiring, network cabling and television distribution wiring installers shall be certified, have a minimum of five (5) years experience in dedicated telecommunication/data installation and shall furnish proof of qualification. Installer shall also provide a list of successful installations over the past three (3) years including contact name and phone number.
- 1.4 DELIVERY, STORAGE, AND HANDLING
 - A. Comply with pertinent provisions of Section 01620.

PART 2 - PRODUCTS

2.1 TELEVISION ACCESSORIES

- A. Provide and install television accessories with all required hardware, of the designs as specified and at the locations as indicated on the drawings.
 - 1. The ceiling mount shall be a yoke style mount of 14 GA steel with a 1" x 1-3/4" tubing for the telescoping center beam and 1/4" x 2" steel for the yoke arms. The mount shall allow for height and width adjustments to accommodate the monitor. The tray shall allow for the attachment of the monitor to the tray and shall match the width adjustment of the yoke brackets. a. Model: TVCY35T-BK.
 - 2. Provide all appropriate mounting hardware for installation as indicated, including but not limited to:
 - a. Ceiling flange: TVCM;
 - b. Mounting brackets: TVUM;
 - c. Escutcheon ring: TVER;
 - d. Mounting plate: TVMP;
 - e. Extension pipe: TV18.
 - 3. Provide the following accessories for installation as indicated: 1. VCR bracket: TVT27-BK tray;
 - 2. Webbed nylon security belt: SB.
- B. Television accessories shall have the following minimum attributes:
 - 1. Mounting installation: ceiling mount;
 - 2. Monitor size: 30"-35" diagonal;
 - Height adjustment: 26"-32";
 Width adjustment: 30"-40";

 - 5. Swivel: 360°; 6. Tilt: 0°-10°;

 - 7. Finish: textured powder paint, flat black;
 - 8. Accessories: VCR bracket and security belt.

2.2 ACCEPTABLE MANUFACTURERS

- A. Provide all products of one manufacturer from the following list:
 - 1. Bretford Manufacturing;
 - 2. H. Wilson Company;
 - 3. Other manufacturers when approved in accordance with Section 01340.

2.3 OTHER MATERIALS

A. Provide all other materials, not specifically described but required for a complete and proper installation, as selected by the Contract, subject to the approval of the Architect.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper

completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

- 3.2 GENERAL INSTALLATION FOR STRUCTURED WIRING
 - A. TIA Structured Cabling Method
 - 1. The cabling method shall be a star topology configuration using a hierarchical series of distribution frames.
 - a. The backbone includes the main distribution frame (MDF) and the intermediate distribution frame (IDF).
 - 2. The first level, the MDF shall link to other levels via the backbone cabling. The MDF may link to the third and final level, the telecommunications room (TR) directly or in large installations it may link to some TRs via an optional second level, the intermediate distribution frame (IDF). The TR terminates the backbone cable and cross-connects to the horizontal cabling. The horizontal cabling terminates at the workstation (WS).
 - Horizontal cabling is the cabling from the TR to the workstation. It includes the cross-connects in the TR; horizontal cable and the outlet at the work areas.
 - 4. Horizontal cabling shall be installed such that it will:
 - a. Facilitate ongoing maintenance, relocations and additions;
 - b. Accommodate future equipment and service changes;
 - c. Accommodate a diversity of user applications, including voice, data, LAN, switching and other building services.
 - B. Roughing-In
 - 1. Always check for shorts, opens and ground when the rough-in is completed.
 - 2. Never splice wires on cable runs. Spliced cable shall be removed and replaced at no additional cost to the owner.
 - Do not exert more than 25 pounds of pulling tension on 4-pair cables. Larger capacity cables should be pulled per the manufacturer's directions.
 - Do not run voice and data cables in parallel with power wiring. Consult industry standards for minimum separation of telecommunications cable from interference sources.
 - 5. Do not bend cable sharply or nick the protective sheath covering the insulated wires.
 - 6. Use plastic non-metallic staples to support wire, and leave the wire loose inside the staples do not drive staples all the way in.
 - 7. Always leave a pull cord in conduit to facilitate running new wire.

- Never run power in the same conduit with telecommunications cable. Low-voltage monitor and control lines may share conduit with telecommunications.
- 9. Avoid under carpet runs.
- 10.Where possible, use inner walls for runs to avoid conflict with firebreaks and insulation. Handling shall be the same as for electrical wire. Firestopping shall be observed.
- 11.Do not run telecommunications cable parallel to power wiring without adequate separation, and do not share bore holes with power wires.
- 12.Keep wire away from sources of heat, such as hot water pipes and heater ducts.
- 13. Avoid running external cables.
- 14.Leave 18 inches of spare wire at outlets and connection points for connections and changes.
- 15. Firestopping, bonding and grounding shall be performed according to applicable fire, building and electrical codes.
- 16.When installing outlet boxes on wooded studs, maintain proper separation of communications and power cables. These two types of cables shall not share drill holes or stud spaces. Desk telephone connectors shall be located at the same distance from the floor as electrical outlets.
- 17.Each workstation shall be served by a minimum of three 100 Ω UTP cables. Single or double outlets may be used.
- 18.Telecommunications outlets shall be placed at the same height as electrical outlets and near an electrical outlet.
- 19.Use the minimum number of connections to avoid degradation of system performance.
- 20.Never install components of unknown/questionable origin or quality.
- 21.Document all connections carefully, and keep installations neat and tidy.

3.3 INSTALLATION

- A. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.
- B. Install the work of this Section in strict accordance with the original design, the approved Shop Drawings, pertinent requirements of governmental agencies having jurisdiction, and the manufacturer's recommended installation procedures as approved by the Owner, anchoring all components firmly into position for long life under hard use.

END OF SECTION

SECTION 16785

CLOSED CIRCUIT TELEVISION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. General Summary: Provide a closed circuit television system for monitoring and security purposes as shown on the Drawings, as specified herein, and as needed for a complete and proper installation.
- B. Related work: Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
- C. Notify Architect when work is scheduled to be installed. Provide a tentative schedule, divided into phases of installation. Use agreed schedule for installation and for field observation by Architect.
- D. The intent of this specification is to provide a complete and satisfactory closed circuit television system.

1.2 SUBMITTALS

- A. Submittals Process: Comply with pertinent provisions of Section 01340.
- B. Product data: Within 60 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Materials list of items proposed to be provided under this Section.
 - 2. Shop Drawings showing all details of fabrication, installation, and anchorage of the work of this Section, and its interface with the work of other trades.
- C. Drawings and Specifications: The contract drawings and these specifications shall be considered as complimentary, each to the other. What is called for by one shall be considered binding as if called for by both. Where conflicts occur, secure clarification from the Architect/Engineer prior to submitting bids; otherwise, provide for the more costly quality or quantity. The drawings are diagrammatical and dimensional figures should be followed in preference to scaling; verify dimensions with the architectural drawings and with field conditions.

1.3 QUALITY ASSURANCE

- A. Workforce: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Experience: Use a subcontractor having not less than five years successful experience in the installation of similar products, as approved by the Architect.
- C. Quality of work: All work shall be executed in a workmanlike manner, so

as to insure a high quality job and to present a neat and mechanical appearance when completed. All materials used shall be new and UL approved for their intended use where such standards have been established.

- D. Applicable Standards: Work included in this section shall comply with all applicable laws of governmental agencies having jurisdiction over said work, and with the latest edition of the National Electrical Code, ANSI/TIA/EIA-569-A standard (Commercial Building Standard for Telecommunication Pathways and Spaces) and its addenda and TIA/EIA-568-B standard (Commercial Building Telecommunications Cabling Standard) and its addenda, where it is not in conflict with those laws.
- E. Site Conditions: Before beginning work, the contractor or subcontractor shall visit the project site and ascertain all existing conditions. Adjustment to the work made necessary by actual field conditions shall be made at no additional cost.
- F. Handle conduit, connectors, terminators, caps, monitors, computer equipment, cameras and other closed circuit television system components with great care to prevent undesired bending, damage and scoring the finish. Store conduit, connectors, terminators, caps, monitors, computer equipment, cameras and other closed circuit television system components inside and protect from harsh environmental elements.
- 1.4 COORDINATION WITH OTHER TRADES
 - A. Coordinate the work in this section so as to conform to the progress of the work of other trades. Phasing of the work shall be done as soon as possible with the entire installation completed as soon as the condition of the building permits. Additionally, Contractor shall review the equipment submittals of all other trades and any Ownerfurnished equipment for physical connection requirements, maximum bend radius, minimum distance between electrical and data wiring, electrical voltage, phase, wiring and load characteristics and wiring details.
- 1.5 SCOPE OF WORK
 - A. The closed circuit television system specified herein shall be of a modular design and nature to facilitate both expansion and service and shall be completely of a solid-state design.
 - B. All conduit, equipment and installation materials required to fulfill the above shall be furnished whether or not specified herein or on the drawings, and shall be subject to approval by the Architect as pursuant to Section 01630.
 - C. The installation supervisor shall instruct designated personnel in the correct operation of the system.
 - D. The contractor shall provide four complete sets of the following: Installation drawings, wiring diagrams, instruction manuals, schematic drawings and service manuals upon completion.
 - E. The system shall be guaranteed by the Contractor for a period of one year from date of acceptance against defective materials, design and

workmanship. Any defective materials shall be replaced at no cost to the owner.

- F. The contractor shall submit to the Architect a detailed test procedure to be used for every section covered under this Section as per Section 01630. All cables shall be tested for maximum length allowance, attenuation, impedance, ground shorts, continuity of communications conductors, shields, NEXT and crosstalk.
- G. The contractor, if requested to do so by the Architect, shall be prepared to show by proof of performance test(s) that the equipment furnished and installed on the job is equal to or exceeds the equipment specifications as listed herein. This proof of performance shall be by actual tests and not by printed technical or sales literature on said products. To this end, the contractor shall provide qualified technicians and such test equipment as necessary to perform these tests. The Architect has final approval of tests to be performed to meet these requirements.

PART 2 - PRODUCTS

- 2.1 BLACK AND WHITE TV CAMERA(S)
 - A. Contractor shall provide 1/2" high-sensitivity solid-state black and white video cameras using an interline transfer charge-coupled device (CCD) image sensor.
 - B. The pickup device shall have a 251,900 pixel array (512 horizontal, 492 vertical) and shall produce a standard EIA NTSC black and white video signal.
 - C. The cameras shall have a composite video output that shall be 1.0 V p-p with 75 ohms impedance video and DC power connections shall be provided for an ES-type auto-iris lens, and an internal auto-iris circuit and external connector shall be provided for CS-G type auto-iris lenses. They shall accept CS-mount lenses, and adapters for C-mount lenses shall be provided.
 - D. The units shall not exceed 1.4 pounds weight each. The cameras shall have an aluminum case to minimize radio frequency interference. Dimensions shall not exceed 6.7" wide, 2.6" high and 2.5" deep. The top and bottom of the cases shall provide a 1/4-20 threaded hole for mounting.
 - E. The signal to noise ratio shall be typically 47 dB and provide a gray scale of 10 steps.
 - F. Two modes for shutter speeds of 1/100 seconds and 1/1000 seconds shall be provided for detailed observation of fast-moving objects.
 - G. The cameras shall have a sensitivity of .010 fc (1 lux), with an output level of 25 IRE (usable video). The cameras shall also have a sensitivity of 0.19 fc (2 lux), with an output level of 50 IRE (usable video).
 - H. External synchronization shall include genlock and line locking with more than 180 degree V-phase adjustment.

- I. Internal synchronization shall be provided by crystal oscillation.
- J. Input power shall be of 24 VAC, at 60 Hz, with entry through a screw terminal. Current requirements shall not exceed 170 mA from an AC power source nor 320 mA from a DC power source.
- K. The units shall be manufactured by Vicon, and be of model VC2700-24.
- 2.02 LENSES
 - A. Contractor shall provide lenses for above referenced cameras of a fixed-focal-length with an auto-iris in a fast, wide angle, 1/2" format.
 - B. Lenses shall have a focal length of 6 mm with an effective aperture range (f-stop) of f/1.2 to f/360.
 - C. The horizontal field angle shall be 56 degrees of 9'0".
 - D. The units shall be manufactured by Vicon, and be of model V6-1.2ES.

2.03 CAMERA POWER SUPPLY

- A. Contractor shall provide power supplies sufficient for established power guidelines sufficient to power each camera.
- B. The camera supply shall provide one 24 VAC output for a total of 4 amps continuous supply current.
- C. Eight individually fused outputs shall be provided.
- D. The unit shall maintain camera synchronization.
- E. The unit shall be manufactured by Altroniz, and be of model ALTV248.

2.04 CAMERA WALL MOUNT

- A. Contractor shall provide a wall mount for each camera to be mounted to an interior wall.
- B. Wall mount shall be of the indoor type, rated for light duty, and constructed of high-impact, light gray plastic designed to support camera/housing combinations weighing up to 7 1/2 pounds.
- C. Wall mount shall have an adjustable head featuring individual locking knobs for horizontal and vertical movement.
- D. Wall mount shall mount to a standard outlet box for concealed cable as specified by Section 16753.
- E. Wall Mount shall weigh no more than 1 1/2 pounds.
- F. The unit shall be manufactured by Vicon, and be of model V1100AWM-LG.
- 2.05 CAMERA CEILING MOUNT

- A. Contractor shall provide a ceiling mount for each camera to be mounted to a ceiling.
- B. Ceiling mount shall be of the indoor type, rated for light duty, and constructed of high-impact, light gray plastic designed to support camera/housing combinations weighing up to 7 1/2 pounds.
- C. Wall mount shall have an adjustable head featuring individual locking knobs for horizontal and vertical movement.
- D. Ceiling mount shall have a body capable of 260 degrees rotation to adjust horizontal positioning.
- E. The unit shall be manufactured by Vicon, and be of model V8000ACM-LG.

2.06 CAMERA HOUSING

- A. Contractor shall provide a camera housing for each camera.
- B. Camera housing shall consist of an extruded tubular aluminum body and removable injection molded black ABS plastic end caps.
- C. Camera housing shall allow for the removal of the rear end cap as to allow for access to a slide out camera mount for installation of camera and lens, and removal of front end cap shall allow for lens adjustments without the need of removing the camera or lens.
- D. Camera housing shall contain a clear front end cap with a viewing window having a viewing area of 2 1/2" by 3 3/4".
- E. Camera housing shall contain a cear end cap with two adjustable compression glands to be used for cable entry with an opening that shall accommodate a 5/16" maximum cable diameter.
- F. Camera housing front and rear end caps shall allow for removal by using a standard-sized Phillips head screwdriver.
- G. Camera housing shall be designed for indoor use and be capable of withstanding temperatures of 120 degrees Fahrenheit.
- H. Camera housing shall be mountable to a ceiling, wall or pedestal mount.
- I. Camera housing body shall be self-textured, semi-floss beige enamel paint.
- J. The unit shall be manufactured by Pelco, and be of model EH4010.

2.07 MONITOR

- A. Contractor shall provide a monitor for viewing camera transmissions.
- B. Monitor shall be of a high-resolution black and white type with a 17" picture tube.

- C. Monitor shall be designed to receive and display EIA NTSC standard composite video signals, and shall have a resolution of more than 500 television lines.
- D. Monitor shall not have a geometric distortion exceeding 3 percent.
- E. Monitor shall provide four input channels: two for composite video, one for separate Y and C inputs from an S-VHS source and one for professional editing VTR.
- F. Front panel controls shall include a power on/off button, vertical hold control, brightness control, contrast control, phase control, source selection button(s), preset select button(s) and aperture compensation selector. A slide switch for video termination shall be located on the rear panel, along with a channel A-B selection switch.
- G. Input power shall be 105-128 VAC at 60 Hz. Power consumption shall be 65 W, typical.
- H. Monitor weight shall not exceed 60 pounds.
- I. The unit shall be manufactured by Vicon, and be of model UM621-4.
- 2.08 QUAD DISPLAY SYTEM
 - A. Contractor shall provide a quad display system for a high-resolution real-time digital image matrix viewing system that shall simultaneously display image information from four video sources on a single monitor by splitting the display into four quadrants.
 - B. Quad display system shall be capable of holding digital information to create free frames on any or all quadrants.
 - C. Quad display system shall be programmable with a set of push-button switches located on the front-panel. On screen menus shall provide information on progress, status and programming instructions. It shall incorporate on-screen programmable titles, time and date retention display and video loss detection, both visual and audible.
 - D. Access to user-programmable features shall be password protected with a user definable password which shall consist of sequential activation of switches on the systems front panel.
 - E. Quad display system shall accommodate video from a video cassette tape playback source by means of standard video and S-VHS input.
 - F. Connections shall be made via corresponding BNC connectors located on the rear of the unit.
 - G. Front panel controls of the quad display system shall be labeled in English with conceptually representative icons and resist fading and wear from frequent use.
 - H. Quad display system shall generate 256-level gray scale resolution with eight chroma bits per channel. Pixel resolution shall be 720 by 484, as compliant with standard NTSC signals.

- I. Quad display system back panel shall include four 75 ohm terminated camera inputs, one standard video cassette recorder playback input and one S-VHS video cassette recorder input made via BNC connectors.
- J. The unit shall be manufactured by Pelco, and be of model PQ4C.
- 2.09 TIME-LAPSE VIDEO CASSETTE RECORDER
 - A. Contractor shall provide a time-lapse video recorder unit based on the VHS 1/2" video cassette standard.
 - B. Time-lapse video recorder shall be front loading, NTSC compatible, have eight time lapse modes (24, 48, 72, 120, 168, 240, 360 and 480h), a two-hour VHS compatible mode, four recording heads, three-motor direct-drive beltless system, audio recording and playback in 2-, 3-, 6- and 12-h modes.
 - C. Time-lapse video recorder shall have seven automatic alarm acknowledgements and one manual alarm acknowledgement, as well as alarm-indexing and scanning alarm search.
 - D. Time-lapse video recorder shall have speed search, forward and reverse, frame-by-frame search, forward and reverse, reverse play, blur-free playback, seven day memory backup, user-selectable auto tape stop or auto-rewind, remote tape-end alarm output and control lock-out switch.
 - E. Time-lapse video recorder display shall be positionable in any of the four corners of the monitor screen.
 - F. Time-lapse video recorder shall accept .5 to 2 v p-p composite video signal at 75 ohms.
 - G. Time-lapse video recorder shall output a 1 v p-p composite video signal at 75 ohms.
 - H. Time-lapse video recorder shall provide audio frequency response of 50 $\,\rm Hz$ to 10 kHz.
 - I. Time-lapse video recorder shall provide a horizontal resolution of no more than 320 lines black and white and no less than 240 lines.
 - J. Time-lapse video recorder head shall provide switching pulse output.
 - K. Time-lapse video recorder shall have an RS-232 interface available as an option.
 - L. The unit shall be manufactured by Vicon, and be of model VCR401.

2.10 POWER CABLE

- A. Contractor shall provide a power cable for each camera.
- B. Power cable shall be one twisted pair of 18 American Wire Guage Standard stranded copper conductors with no less than 7x26 strands per conductor.
- C. Power cable insulation of each conductor shall be .01 inches of copolene, and the overall jacket shall .02 inches of poly-vinyl chloride.
- D. Power cable nominal outside diameter shall be .165 inches.
- E. The unit shall be manufactured by West Penn, and be of model 224.
- PART 3 EXECUTION

3.01 PROJECT CONDITIONS

- A. Upon completion, it shall be the responsibility of the Contractor to perform the necessary mixing, matching and balancing of signals for a properly operating system as described here-in.
- B. A demonstration shall be performed in the presence of an authorized representative of the Architect. The Contractor shall forward a letter stating this has been carried out and name the person(s) in attendance for the demonstration.
- C. At the time of project closeout, submit a minimum of four sets each product manual.

3.02 EQUIPMENT

- A. Protect finished installation from damage by other trades.
- B. Remove rubbish and left over materials from the site.
- C. Provide one year warranty on the entire system including on site labor during normal working hours at no cost to the Owner for a period of twelve months from the date of acceptance.
- D. Guarantee response to a trouble call within one normal business day after receipt of such call.
- E. Contractor shall provide a written agreement outlining warranty acceptance.

3.03 INSTALLATION

- A. Follow guidelines for Data Raceway System installation, as pursuant to Section 16753.
- B. Follow guidelines for cable securing, installation, and termination, as pursuant to Section 16760.

- C. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected. Failure to examine and/or correct existing conditions will not relieve the contractor of responsibility for the proper operation of this work nor be the basis for a claim for additional compensation by the Owner. Install the work of this section in strict accordance with manufacturer's written instructions, the approved submittals, and shop drawings.
- D. Coordinate with other trades to assure proper and adequate provisions in the work of those trades for interface with the work of this section.
- E. Install each item in its proper location, fire-caulked in all areas where required by the Electrical Code, firmly anchored into position, level, and plumb, and in accordance with the manufacturer's recommendations.

SECTION 16786

MEETING ROOM SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. General Summary: Provide a complete and functional meeting room audio/visual system where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.
- B. Related work: Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
- C. Notify Architect when work is scheduled to be installed. Provide a tentative schedule, divided into phases of installation. Use agreed schedule for installation and for field observation by Architect.

1.2 SUBMITTALS

- A. Submittals Process: Comply with pertinent provisions of Section 01340.
- B. Product data: Within 60 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Materials list of items proposed to be provided under this Section.
 - 2. Shop Drawings showing all details of fabrication, installation, and anchorage of the work of this Section, and its interface with the work of other trades.
- C. Drawings and Specifications: The contract drawings and these specifications shall be considered as complimentary each to the other. What is called for by one shall be considered binding as if called for by both. Where conflicts occur, secure clarification from the Architect/Engineer prior to submitting bids; otherwise, provide for the more costly quality or quantity. The drawings are diagrammatical and dimension figures should be followed in preference to scaling; verify dimensions with the architectural drawings and with field conditions.

1.3 QUALITY ASSURANCE

- A. Workforce: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Experience: Use a subcontractor having not less than five years successful experience in installation of similar products, as approved by the Architect.
- C. Quality of work: All work shall be executed in a workmanlike manner so as to insure a high quality job and to present a neat and mechanical appearance when completed. All materials used shall be new and UL approved for their intended use where such standards have been established.

- D. Applicable Standards: Work included in this section shall comply with all applicable laws of governmental agencies having jurisdiction over said work, and with the latest edition of the National Electrical Code, ANSI/TIA/EIA-569-A standard (Commercial Building Standard for Telecommunication Pathways and Spaces) and its addenda and TIA/EIA-568-B standard (Commercial Building Telecommunications Cabling Standard) and its addenda, where it is not in conflict with those laws.
- E. Site Conditions: Before submitting a bid the contractor or subcontractor shall visit the project site and ascertain all existing conditions. Adjustment to the work made necessary by actual field conditions shall be made at no additional cost.
- F. Handle conduit, connectors, terminators, caps and other raceway system components with great care to prevent undesired bending, end damage and scoring the finish. Store conduit, connectors, terminators, caps and other raceway system components inside and protect from harsh environmental elements. When necessary to store outdoors, elevate the components well above grade and enclose with durable, watertight wrapping.
- 1.4 COORDINATION WITH OTHER TRADES
 - A. Coordinate the work in this section so as to conform to the progress of the work of the other trades. Phasing of the work shall be done as soon as possible with the entire installation compiled as soon as the condition of the building permits. As well, review the equipment submittals of all other trades and any Owner-furnished equipment for physical connection requirements, maximum bend radius, minimum distance between electrical and data wiring, electrical voltage, phase, wiring and load characteristics and wiring details.
- PART 2 PRODUCTS
- 2.1 GENERAL
 - A. All Materials are to be new and of the type and quality specified. Materials must be delivered by labeled, unopened containers. All electrical products must bear the U.L. label.
- 2.2 VISUAL PROJECTOR
 - A. Contractor shall provide a visual projector capable of displaying no less than 2000 ANSI lumens.
 - B. Projector shall provide an 800 pixel by 600 pixel minimum viewing resolution.
 - C. Projector shall be capable of receiving a wireless signal using standard 802.11b radio frequency transmission protocol.
 - D. The unit shall be manufactured by inFocus, and be the model type LP500. The unit shall also include a LP-LITESHOWCARD model wireless access system.

2.2 WIRELESS LAPEL MICROPHONE SYSTEM

- A. Contractor shall provide a wireless microphone system capable of broadcasting over the VHF frequency range.
- B. Transmitter shall have an on/off switch, mute switch, power indicator, low battery indicator and manual audio gain control.
- C. Receiver shall have a two telescoping antennas, a 1/4" unbalanced audio output connector and a volume control.
- D. Microphone shall be a wearable, lapel-type microphone of the supercardoid type. Microphone shall have a pick-up angle of 90-115 degrees.
- E. The receiver unit shall be manufactured by Shure, and be the model type T4A.
- F. The transmitter unit shall be manufactured by Shure, and be the model type T1.
- G. The microphone unit shall be manufactured by Shure, and be the model type WL184.
- H. The three components shall be purchased as a bundle, as manufactured by Shure, and be of the model type TPD/84.

2.3 POWER AMPLIFIERS

- A. Contractor shall provide power amplifiers necessary to provide 35 watts of continuous power with no less than 1 percent distortion from 20 to 20 kHz to each area specified in Section 1 of these specifications.
- B. Power amplifiers shall provide five main inputs, an auxiliary input, and a telephone/pager input.
- C. Power amplifiers shall have a signal-to-noise ratio greater than 70 dB for auxiliary inputs and telephone/pager inputs.
- D. Power amplifiers shall have a frequency response from 20 to 20 KHz, plus or minus 1 dB, at 9 dB below rated output per EIA SE-101A specifications.
- E. Power amplifiers shall provide electronic fold-back and thermal overload self-restoring protection circuits, with 30 dB of muting.
- F. Power amplifiers shall provide independent input controls for five main inputs, as well as a power switch, on the front panel.
- G. The unit shall be manufactured by Dukane, and be of model 1A1635.

2.04 ELECTRIC PROJECTION SCREEN

- A. Contractor shall provide an electric concealing glass-beaded projection screen.
- B. Projector screen shall be placed and installed as shown on the drawings and per manufacturer's instructions.
- C. Project shall be 50" in width and 50" in height.
- D. A controller with push-button switches for raising and lowering the screen shall be provided. Switch shall be manufactured by Da-Lite and be compatible with the projection screen system specified in this section.
- E. Project shall be manufactured by Da-Lite, and be of the model series Cosmopolitan Electrol meeting outlined specifications.

2.05 OTHER MATERIALS

- A. All other materials and accessories, not specifically described or called for, but are necessary for a complete finished installation for the work of this section shall be furnished and installed by the Contractor at no additional cost. These materials shall be selected by the Contractor and approved by the Architect.
- B. All selected materials must be approved by the Architect, with information submitted to the Architect as pursuant to Section 01340.

PART 3 - EXECUTION

3.01 PROJECT CONDITIONS

- A. Upon completion, it shall be the responsibility of the Contractor to perform the necessary mixing, matching and balancing of signals for a properly operating system as described here-in.
- B. A demonstration shall be performed in the presence of an authorized representative of the Architect. The Contractor shall forward a letter stating this has been carried out and name the person(s) in attendance for the demonstration.
- C. At the time of project closeout, submit a minimum of four sets each product manual.

3.02 EQUIPMENT

- A. Protect finished installation from damage by other trades.
- B. Remove rubbish and left over materials from the site.
- C. Provide one year warranty on the entire system including on site labor during normal working hours at no cost to the Owner for a period of twelve months from the date of acceptance.

- D. Guarantee response to a trouble call within one normal business day after receipt of such call.
- E. Contractor shall provide a written agreement outlining warranty acceptance.

3.03 INSTALLATION

- A. Follow guidelines for Data Raceway System installation, as pursuant to Section 16753.
- B. Follow guidelines for cable securing, installation, and termination, as pursuant to Section 16760.
- C. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected. Failure to examine and/or correct existing conditions will not relieve the contractor of responsibility for the proper operation of this work nor be the basis for a claim for additional compensation by the Owner. Install the work of this section in strict accordance with manufacturer's written instructions, the approved submittals, and shop drawings.
- D. Coordinate with other trades to assure proper and adequate provisions in the work of those trades for interface with the work of this section.
- E. Install each item in its proper location, fire-caulked in all areas where required by the Code, firmly anchored into position, level, and plumb, and in accordance with the manufacturer's recommendations.
- F. Controller for projector screen shall be installed by the Electrical contractor according to manufacturer's specifications.

SECTION 16787

INTERNET ACCESS

PART 1 - GENERAL

1.1 SUMMARY

- A. General Summary: Provide high speed internet access for guests to access email, the world wide web, and other publicly accessible internet information as shown on the Drawings, as specified herein, and as needed for a complete and proper installation.
- B. Related work: Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
- C. Notify Architect when work is scheduled to be installed. Provide a tentative schedule, divided into phases of installation. Use agreed schedule for installation and for field observation by Architect.
- D. The intent of this specification is to provide a complete and satisfactory high speed internet access system.

1.2 SUBMITTALS

- A. Submittals Process: Comply with pertinent provisions of Section 01340.
- B. Product data: Within 60 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Materials list of items proposed to be provided under this Section.
 - 2. Shop Drawings showing all details of fabrication, installation, and anchorage of the work of this Section, and its interface with the work of other trades.
- C. Drawings and Specifications: The contract drawings and these specifications shall be considered as complimentary each to the other. What is called for by one shall be considered binding as if called for by both. Where conflicts occur, secure clarification from the Architect/Engineer prior to submitting bids; otherwise, provide for the more costly quality or quantity. The drawings are diagrammatical and dimension figures should be followed in preference to scaling; verify dimensions with the architectural drawings and with field conditions.

1.4 QUALITY ASSURANCE

- A. Workforce: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Experience: Use a subcontractor having not less than five years successful experience in installation of similar products, as approved by the Architect.

- C. Quality of work: All work shall be executed in a workmanlike manner so as to insure a high quality job and to present a neat and mechanical appearance when completed. All materials used shall be new and UL approved for their intended use where such standards have been established.
- D. Applicable Standards: Work included in this section shall comply with all applicable laws of governmental agencies having jurisdiction over said work, and with the latest edition of the National Electrical Code, ANSI/TIA/EIA-569-A standard (Commercial Building Standard for Telecommunication Pathways and Spaces) and its addenda and TIA/EIA-568-B standard (Commercial Building Telecommunications Cabling Standard) and its addenda, as well as generally considered quality standards for high speed internet access, where it is not in conflict with those laws.
- E. Site Conditions: Before submitting a bid the contractor or subcontractor shall thoroughly familiarize himself with these specifications and drawings and ascertain all requirements. Adjustment to the work made necessary by actual field conditions shall be made at no additional cost.
- F. Handle conduit, connectors, terminators, caps, wireless access points, switches, hubs and other high speed internet access system components with great care to prevent undesired bending, damage and scoring the finish. Store conduit, connectors, terminators, caps, monitors, computer equipment, cameras and other closed circuit television system components inside and protect from harsh environmental elements.

1.5 COORDINATION WITH OTHER TRADES

A. Coordinate the work in this section so as to conform to the progress of the work of the other trades. Phasing of the work shall be done as soon as possible with the entire installation completed as soon as the condition of the building permits. As well, review the equipment submittals of all other trades and any Owner-furnished equipment for physical connection requirements, maximum bend radius, minimum distance between electrical and data wiring, electrical voltage, phase, wiring and load characteristics and wiring details.

1.6 SCOPE OF WORK

- A. The high speed internet access system specified herein shall be of a modular design and nature to facilitate both expansion and service and shall be completely of a solid-state design, with the exception of fans used for equipment cooling
- B. All conduit, equipment and installation materials required to fulfill the above shall be furnished whether or not specified herein or on the drawings, and shall be subject to approval by the Architect as pursuant to Section 01630.
- C. The installation supervisor shall instruct designated personnel in the correct operation of the system.

- D. The contractor shall provide four complete sets of the following: Installation drawings, wiring diagrams, instruction manuals, schematic drawings and service manuals upon completion.
- E. The system shall be guaranteed for a period of one year from date of substantial completion against defective materials, design and workmanship. Any defective materials shall be replaced at no cost to the owner.
- F. The contractor shall submit to the Architect a detailed test procedure to be used for every section covered under this Section as per Section 01630. All cables shall be tested for length, attenuation, impedance, ground shorts, continuity of communications conductors, shields, NEXT and crosstalk.
- G. The contractor, if request to do so by the Architect, shall be prepared to show by proof of performance test(s) that the equipment furnished and installed on the job is equal to or exceeds the equipment specifications as listed herein. This proof of performance shall be by actual tests and not by printed technical or sales literature on said products. To this end, the contract shall provide qualified technicians and such test equipment as necessary to perform these tests. The Architect has final approval of tests to be performed to meet these requirements.
- H. Contractor shall provide the names of sub-contractors qualified to complete said work to the Architect as part of the bid package. Said sub-contractor shall be qualified to terminate cable in 110 and 66 style punch blocks, connectors and terminators, as well as be able to terminate and construct patch cables into RJ-45 and RJ-11 connectors.
- I. Contractor shall not be responsible for connecting PBX room equipment or backboard equipment. Contractor shall be responsible for terminating room outlets. HSIA provider and the Architect will provide continuity tests and signal degradation tests, as specified in Section 16760.

PART 2 - PRODUCTS

2.1 WIRELESS ACCESS POINTS

- A. Contractor shall provide wireless access points for the purpose of connecting wireless internet access clients to the local area network (LAN) contained within the hotel, and allowing for access from the LAN to a public switched wide area network (WAN), with access to the publicly switched Internet.
- B. Wireless access points shall provide 802.11b standard wireless access signals to clients. Wireless access points shall emit signals in the 2.54 GHz signal range.
- C. Wireless access points shall provide port-to-port security, such that no user may access another computer on the wireless network, another computer on the wired segment of the network, another computer within the hotel, nor can any other computer access another user's computer. Wireless access points shall also be able to block computers and users from initiating and creating "ad-hoc" wireless networks, or computerto-computer network connections.

- D. Wireless access points shall provide a firmware upgrade function for updating the software that controls each wireless access point. Additionally, each wireless access point must be centrally administrable from the service providers or equipment providers network operations center (NOC).
- E. Wireless access points shall provide a 3-year equipment manufacturer's warranty, either included with the price of the equipment or as an addon package, allowing for 2 business day turnaround on non-critical service calls, and on-site service within 1 business day for critical service calls. If on-site service is not available in the area of the site to be constructed, next-day shipment of a replacement product that is pre-configured for the said site shall be provided.
- F. Telephone support for non-critical problems that can be corrected via remote access by the service provider, equipment provider or manufacturer shall be provided. Hold times for said calls shall be less than 15 minutes.
- G. Telephone support for critical problems that cannot be corrected via remote and must be repaired by either be a replacement product or physical repair by the service provider, equipment provider or manufacturer shall be provided. Hold times for said calls shall be less than 15 minutes.
- H. Wireless access points shall provide bi-pole directional style antenna, except in the lobby and pool areas, where it shall have an omnidirectional style antenna.
- I. Wireless access points shall be manufactured by Hewlett-Packard, and be model type HP WAP 420 NA (Manf. No. HPJ8130A), or shall be manufactured by Cisco Systems, and be model type Cisco Aironet 11000 AP 802.11b (Manf. No. AIR-AP1120B-A-K9).
- 2.02 POWER INJECTORS
 - A. Contractor shall provide power injectors for providing power to WAPs where necessary.
 - B. Any telecommunications or data distribution equipment not placed in the MDF shall be powered by the entering data or telecommunications backbone cabling.
 - C. If contractor uses a solution that provides Power Over Ethernet, specified as equipment that adheres to the Institute of Electrical and Electronics Engineers, Inc. (IEEE) 802.3af specifications, power injectors shall not be required for access points and other network equipment, requiring power that support this standard.
 - D. Power injectors shall be manufactured by the manufacturer of the Wireless Access Point or other network solution requiring power.
 - E. Contractor shall use, in the case of Cisco Systems Aironet Wireless Access Points, power injectors manufactured by Cisco, and be model type Cisco 1100-1200 Series Power Injectors (Manf. No. CIS-AIR-PWRINJ3).

2.03 SWITCH

- A. Contractor shall provide a switch for routing and connecting wireless access points, data outlets and other Ethernet-based communications systems.
- B. Switch shall provide 24 ports of 10/100 Mbps speed, and be of the intelligent routing type.
- C. Switch shall allow for remote access via HTTP from any standard internet web browser.
- D. Switch shall allow for virtual private network (VPN) pass-through, including, but not limited to, IPsec, LTTP, PPTP and other VPN access.
- E. If Switch is to be used with Wireless Access Points that provide Power Over Ethernet, as pursuant to IEEE 802.3af standards, switch shall provide said POE and be fully compliant with IEEE 802.3af standards.
- F. Contractor shall use, in the case of Cisco Systems Aironet Wireless Access Points, a switch manufactured by Cisco, and be model type Cisco 2950 Switch 24-port 10/100 (Manf. No. CIS-WS-C2950-24), or in the case of Hewlett Packard Procurve Wireless Access Points, contractor shall use a switch manufactured by Hewlett Packard, and be model type HP ProCurve Switch 2626-PWR (Manf. No. HP J8164A).
- 2.04 GATEWAY
 - A. Contractor shall provide a Gateway server that will introduce a forced start page (FSP) upon guest connection to the internet, provide advanced routing and network monitoring capabilities, allow remote administration personnel to administer and troubleshoot the internal components of the network and provide firewall protection from the public switched internet to the hotel.
 - B. Gateway shall be manufactured by Nomadix, and be model type HSG-100.

PART 3 - EXECUTION

3.01 PROJECT CONDITIONS

- A. Upon completion, it shall be the responsibility of the Contractor to perform the necessary mixing, matching and balancing of signals for a properly operating system as described here-in.
- B. Contractor shall leave a minimum of 3'0" of cable at each cable endpoint, as specified in the drawings, for termination by the HSIA provider.
- C. At the time of project closeout, submit a minimum of four sets each product manual.

3.02 EQUIPMENT

A. Protect finished installation from damage by other trades.

- B. Remove rubbish and left over materials from the site.
- C. Provide one year warranty on the entire system including on site labor during normal working hours at no cost to the Owner for a period of twelve months from the date of acceptance.
- D. Guarantee response to a trouble call within one normal business day after receipt of such call.
- E. Contractor shall provide a written agreement outlining warranty acceptance.
- 3.03 INSTALLATION
 - A. Follow guidelines for Data Raceway System installation, as pursuant to Section 16753.
 - B. Follow guidelines for cable securing, installation, and termination, as pursuant to Section 16760.
 - C. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected. Failure to examine and/or correct existing conditions will not relieve the contractor of responsibility for the proper operation of this work nor be the basis for a claim for additional compensation by the Owner. Install the work of this section in strict accordance with manufacturer's written instructions, the approved submittals, and shop drawings.
 - D. Coordinate with other trades to assure proper and adequate provisions in the work of those trades for interface with the work of this section.
 - E. Install each item in its proper location, fire-caulked in all areas where required by the Electrical Code, firmly anchored into position, level, and plumb, and in accordance with the manufacturer's recommendations.
 - F. Contractor shall also provide data two data outlets in the meeting room, two data ports in the general manager's office, two data ports in the joint office, two data ports in the meeting room, two data ports behind the night desk workstation, four data ports behind the front desk, and other locations as deemed appropriate by the Owner and or Architect.

SECTION 16790

TERMINATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Properly terminate all structured wiring cable in accordance with the following using special tools specifically designed for each type of termination.
- B. Related work:
 - Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
 - 2. TIA specifications T568B;
 - 3. Section 01720: Project Record Documents;
 - 4. Section 01730: Operation and Maintenance;
 - 5. Section 16753: Data Raceway Systems;
 - 6. Section 16760: Audio/Visual/Telecommunications Systems;
 - 7. Section 16765: Television Distribution System;
 - 8. Section 16780: Background Music/Music On Hold Systems;
 - 9. Section 16785: Closed Circuit Television Systems;
 - 10. Section 16786: Meeting Room Systems;
 - 11. Section 16787: High Speed Internet Access.

1.2 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.
 - 1. Technicians shall furnish evidence of current certification by BICSI and/or RCDD.

1.3 DELIVERY, STORAGE AND HANDLING

A. Use adequate numbers of skilled workmen who are thoroughly trained.

PART 2 - PRODUCTS

(No products are required in this Section)

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and

proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.2 WORKMANSHIP

- A. Produce terminations which are properly punched down and secure with all members assembled in accordance with the drawings and specifications which fully allows for the specified transmission.
- 3.3 GENERAL TERMINATION REQUIREMENTS
 - A. Do not bend cable sharply or nick the protective sheath covering the insulated wires.
 - B. Maintain polarity by carefully matching wire colors of the Tip (+) and Ring (-) pairs from the demarcation point to the outlets.
 - C. Maintain the access line number correlation with the pair number when wiring connectors.
 - D. Use the two inner pairs of a housing for telecommunication. Use the outer pairs of the connector for other purposed (if any) to provide compatibility with two-line telephones.
 - E. Leave 18 inches of spare wire at outlets and connection points of connections and changes.
 - F. Each workstation shall be served by a minimum of two, 100 Ω UTP cables. Single or double outlets may be used.
 - G. Never install components of unknown/questionable origin or quality.
 - H. Document all connections carefully, and keep installations neat and tidy.
 - I. Test all connections.

3.4 SPECIFIC TERMINATION REQUIREMENT

- A. Where data cabling is terminated into a snap-in connector module and/or 110-style punch block, contractor shall use a multi-pair punch down tool with a 4-pair head specified for use in terminating CAT 6 cabling to 110-style punch down devices.
- B. Where data cabling is terminated into a snap-in connector module and/or 110-style punch block, contractor shall allow no more than 1/2" of untwisting of conductor pairs from termination point downward the cable. Re-cut the cable and re-terminate all connections where more than 1/2" of conductor is untwisted still allowing for the 18" of spare wire at each outlet. Remove wire and re-pull new wire where these conditions are not met at no additional cost to the owner.
- C. Where data cabling is terminated into a snap-in connector module and/or 110-style punch block, contractor shall leave no more than 2" of exposed conductor pairs removed from sheathing.

- D. Where telecommunications cabling is terminated into a 66-style punch block, contractor shall use a punch down tool specified for use in terminating cabling to 66-style punch down devices.
- E. Contractor shall use care when removing sheathing from both data and telecommunications cabling. Where nicks or cuts are caused to conductors, contractor shall cut cabling 1/2" below nicked on cut conductor and remove sheathing again.
- F. Where video/CCTV cabling is terminated, the contractor shall use a crimping tool specified for use with the appropriate style of crimpon F-type ends.
- G. Contractor shall install C-4 style clips onto the 110-style punch block using a multi-pair punch down tool with a 4-pair head, specified for use in terminating CAT6 IDC C-4 style clips to 110style punch down devices.
- H. Contractor shall install 110-style patch cords from the 110-style punch block to the back of the 110-style patch panel.
- I. Contractor shall install 25-pair voice cable from each 66-style punch blocks to the voice grade patch panel.
- J. Contractor shall place unopened data patch cables in a secure, indoor environment location and shall hand them over to the Owner at time of project closeout.
- K. Contractor shall install bridging clips to ensure proper telephone service to each individual extension.
- L. Contractor shall coordinate with telephone service provider and telephone equipment installer to ensure proper operation of the entire telephone system.
- M. Contractor shall install punch block standoffs to each 66-style punch block prior to terminating conductors onto the 66-style punch block.
- N. Contractor shall terminate appropriate cables to appropriate snap-in connectors at each outlet prior to installing snap-in connectors to wall plate housing.
- O. Connectors shall be color coded and all connectors of each system shall be of one unique color throughout the entire installation.

3.5 INSTALLATION OF OTHER ITEMS

A. Install all items in strict accordance with the Drawings, and the recommended methods of the manufacturer as approved by the Architect, anchoring firmly into position at the prescribed location, straight, plumb, and level.

3.6 CLEANING

- A. Keep the premises in a neat, safe, and orderly condition at all times during execution of this portion of the work, free from accumulation of parts, tools, equipment or debris.
- B. Sweeping:
 - 1. At the end of each working day, and more often if necessary, thoroughly sweep surfaces where refuse from this portion of the work has settled.
 - 2. Remove the refuse to the area of the job site set aside for its storage.
 - 3. Upon completion of this portion of the work, thoroughly clean all surfaces removing deleterious and/or foreign materials including fingerprints, smudges, paint, dirt and/or grime.