



**DULUTH INTERNATIONAL AIRPORT**

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**DULUTH INTERNATIONAL AIRPORT  
NEW PASSENGER TERMINAL  
BID PACKAGE 2C- SITEWORK, APRON, CONCESSIONS & FURNISHINGS  
CONTRACT DOCUMENTS  
ISSUE FOR BID**

FAA AIP No. - 3-27-0024-54-12  
RS&H PROJ. No. – 214.1882.091  
CITY OF DULUTH BID No. 12-4401

**PROJECT MANUAL  
VOLUME 4 OF 4**

Date: FEBRUARY 10, 2012



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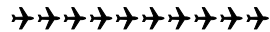
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**NEW PASSENGER TERMINAL  
DULUTH INTERNATIONAL AIRPORT  
DULUTH, MINNESOTA**

**SECTION 16050 - BASIC ELECTRICAL  
MATERIALS AND METHODS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 16.

**1.2 SUMMARY**

- A. This Section includes general requirements for electrical installations. These requirements are applicable to all Division 16 work. The following requirements are included in this Section to expand the requirements specified in Division 1:
  - 1. Submittals.
  - 2. Coordination drawings.
  - 3. Record documents.
  - 4. Maintenance manuals.
  - 5. Rough-ins.
  - 6. Electrical installations.
  - 7. Cutting and patching.
  - 8. Codes, Permits and Inspections.
  - 9. Separation of Work Between Trades.
  - 10. Definitions and Interpretations.
  - 11. Energy Conservation Rebate Programs.

**1.3 SUSTAINABLE DESIGN**

- A. Sustainable Design Intent: Comply with project requirements intended to achieve a Certified Rating, measured and documented according to the LEED Green Building Rating System, of the US Green Building Council.
- B. LEED Certification Documentation: Submit documentation from the manufacturer highlighting LEED requirements for materials and products of this Section.

- C. Comply with the requirements of Division 1 Section "LEED REQUIREMENTS".
- D. Construction Waste Management: Comply with the requirements of Division 1, Section "Construction Waste Management", for removal and disposal of construction debris and waste.

#### 1.4 SUBMITTALS

- A. General: Follow the procedures specified in Division 1 Section "SUBMITTALS."
- B. Additional copies may be required by individual sections of these Specifications.

#### 1.5 COORDINATION DRAWINGS

- A. Prepare coordination drawings in accordance with Division 1 to a scale of 1/4"=1'-0" (1:50) or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components in all electric rooms including 1<sup>st</sup> floor main electrical room, 2<sup>nd</sup> floor electrical room and 3<sup>rd</sup> floor electrical room. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
  - 1. Indicate the proposed locations of major raceway systems, equipment, and materials. Include the following:
    - (a) Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
    - (b) Exterior wall and foundation penetrations.
    - (c) Fire-rated wall and floor penetrations.
    - (d) Equipment connections and support details.
    - (e) Sizes and location of required concrete pads and bases.
  - 2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
  - 3. Prepare floor plans, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

## B. Project Coordination Drawings

1. This Trade shall add to Coordination Drawings prepared by the HVAC Contractor showing all of the electrical work (equipment, conduit, etc.) to be installed as part of the work of this section of the specifications.
2. Requirements for vibration isolation and seismic restraints shall be shown on the coordination drawings by each trade.
3. This Trade after showing all of the electrical work shall forward the completed electronic AutoCAD files to the General Contractor/Construction Manager.
4. The Electrical Contractor shall attend a series of meetings arranged by the General Contractor/Construction Manager to resolve any real or apparent interferences or conflicts with the work of the other Contractors.
5. The Electrical Contractor shall then make adjustments to his work on the Coordination Drawings to resolve any real or apparent interferences or conflicts.
6. After any real or apparent interferences and conflicts have been incorporated into the Coordination Drawings, the Electrical Contractor shall "sign-off" the final Coordination Drawings.
7. The Electrical Contractor shall not install any of this work prior to "sign-off" of final Coordination Drawings. If the electrical work proceeds prior to sign-off of Coordination Drawings, any change to the electrical work to correct the interferences and conflicts which result will be made by the Electrical Contractor at no additional cost to the project.

## 1.6 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, comply with the following:
  1. A complete set of "as-built" or record electric drawings shall be made up and delivered to the Architect.
  2. The drawings shall show:-
    - (a) All electric work installed exactly in accordance with the original design.
    - (b) All electric work installed as a modification or addition to the original design.

- (c) The dimensional information necessary to delineate the exact location of all circuitry and wiring runs (other than lighting and appliance branch circuitry and small control, signal and communications runs) which are so buried or concealed as to be untraceable by inspection through the regular means of access established for inspection and maintenance.
  - (d) The numbering information necessary to correlate all electrical energy consuming items (or outlets for same) to the panel or switchboard circuits from which they are supplied.
- 3. The drawings shall be produced using AutoCAD software. The design drawing files will be made available should it be determined that such files would serve as suitable backgrounds for the "as-built" drawings. These documents remain the property of Cosentini Associates and may be used for no other purpose without expressed, written consent. The contractor shall assume all liabilities resulting from unauthorized use or modifications to the drawings.
- 4. "As-built" information shall be submitted as follows:
  - (a) CADD drawing files on CD-R in AutoCAD format.
  - (b) One (1) set of reproducible drawings.
  - (c) Two (2) sets of blueprints.
- 5. The quantity of design drawings which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show the required "as-built" information.
- 6. Progress prints of record drawings shall be submitted monthly during the construction period for Architect's approval.

## 1.7 MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with Division 1. In addition to the requirements specified in Division 1, include the following information for major equipment items such as engine generator set(s), UPS equipment, alarm system(s), communications systems, transformers, busways, switchgear, switchboards, panelboards, automatic transfer switches, lighting fixtures, and other items as specified elsewhere.
  - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer's printed operating procedures include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

#### 1.9 CODES, PERMITS AND INSPECTIONS

- A. All work shall meet or exceed the latest requirements of all national, state, county, municipal, and other authorities exercising jurisdiction over electrical construction work and the project.
- B. All required permits and inspection certificates shall be obtained, paid for, and made available at the completion of the work.
- C. Any portion of the work which is not subject to the requirements of an electric code published by a specific authority having jurisdiction shall be governed by the National Electrical Code and other applicable sections of the National Fire Code, as published by the National Fire Protection Association.
- D. Equipment, material, layout and installation provided as part of the electrical work shall conform to the requirements of all agencies having jurisdiction. Include as part of the electrical work all required filings and submissions for approval. Equipment furnished separate from - but installed as part of - the electrical work, which does not have all necessary approvals, shall not be installed until approvals are obtained by the parties furnishing the equipment.
- E. Installation procedures, methods and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Administration (OSHA).
- F. All equipment furnished as part of the electrical work shall comply with the latest editions of all applicable state and municipal "energy codes." Provide certification from the equipment suppliers for all energy-consuming equipment that the equipment fully complies with these codes. Equipment submissions will not be accepted for review unless accompanied by such certification in writing.

## 1.10 GUARANTEES AND CERTIFICATIONS

- A. All work shall be guaranteed to be free from defects. Any defective materials or workmanship as well as damage to the work of all trades resulting from same shall be replaced or repaired as directed for the duration of stipulated guaranteed periods.
- B. The duration of guarantee periods following the date of beneficial use of the system shall be one year. Beneficial use is defined as operation of the system to obtain its intended use.
- C. The date of acceptance shall be the date of the final payment for the work or the date of a formal notice of acceptance, whichever is earlier.
- D. Non-durable items such as electric lamps, shall be replaced up to the date of acceptance, such that they shall have had no more than 100 hours use prior to this date.
- E. Certification shall be submitted attesting to the fact that specified performance criteria are met by all items of electrical equipment for which such certifications is required.

## 1.11 SEPARATION OF WORK BETWEEN TRADES

- A. The specifications for the overall construction delineate various items of work under separate trade headings. The list below sets forth this delineation to the extent that it affects the electric work.
- B. In the absence of more detailed information, the list shall be taken as a specific instruction to the electrical trade to include the work assigned to it.
- C. Indications that any trade is to perform an item of work means that it is to perform the work for its own accommodation only, except as specifically noted otherwise.

Oth = Other than electrical or mechanical.

Plb = Plumbing

FP = Fire Protection

Htg = Heating, Ventilating & Air Conditioning

Elec = Electrical.

f = Furnished.

i = Installed.

p = Provided (furnished and installed).

Item	Oth	Plb	FP	Htg	Elec	Note
Motors for mechanical equipment.		p	p	p		
Motor controllers for: Htg Plb FP		f f	f	f	i i	Specifications and drawings delineate exceptions.  Includes motor control centers if applicable.
Motor control devices for: Htg Plb FP		p	p	p		Specifications and drawings delineate exceptions.  Control devices for mounting within controller are provided integral with controller.
Power wiring for motors: Htg Plb FP					p p	
Control wiring for motor controllers: Htg Plb FP				p	p p	Specifications and drawings delineate exceptions.
Temporary light and power.	p					See General conditions specifications.  To accommodate all trades.
Temporary water.	p					



Item	Oth	Plb	FP	Htg	Elec	Note
Temporary heat.	p					
Temporary toilets.	p					
Hoisting.					p	
Rigging.					p	
Bracing and dunnage for safe rigging.					p	
Cutting, chasing and patching.	p					Cost where due to late installation or improper coordination of work is the responsibility of the electric.
Framed slots and openings in walls, decks and slabs.	p					Coordination drawings are required from the electric.
Sleeves through non-waterproof slabs, decks and walls.					p	Includes drilling of holes when required.
Sleeves through waterproof slabs, decks and walls.					p	Includes drilling of holes for other than field poured concrete.
Waterproof sealing of sleeves through waterproof slabs, decks and walls.					p	
Fireproof sealing (fire-stopping) excess opening spaces in slabs, decks and fire-rated walls.					p	
Excavation and backfill inside buildings.	p					
Excavation and backfill outside buildings.					p	
Concrete encasement of conduits.					p	Red coloring for concrete encasing primary voltage runs included in electric.

Item	Oth	Plb	FP	Htg	Elec	Note
Electric manholes and handholes.					p	Furnishing of covers, associated frames and other hardware included in electric.
Fastenings.					p	
Supports.					p	
Flashing of electric conduits through roof (pitch pockets).	p					
Concrete foundations, pads and bases inside buildings.	p					Furnishing of anchors and vibration mounts included in the electric.
Concrete foundations, pads and bases outside buildings.					p	Furnishing of anchors and vibration mounts included in the electric.
Concrete lined trenches in building foundation.	p					
Field touch-up painting of damaged shop coats.					p	
Field rustproof painting of supporting steel members, frames and racks.					p	
Finish painting of exposed work.	p					Red coloring of exposed fire protection alarm systems circuitry included in electric.  Red and white striping of exposed primary voltage runs included in electric.
Finished wall and ceiling access doors, panels and supporting frames.	i				f	Supplying list of locations where required included in electric.
Permanent catwalks to equipment.	p					Supplying list of locations where required included in electric.

Item	Oth	Plb	FP	Htg	Elec	Note
Permanent ladders to equipment.	p					Supplying list of locations where required included in electric.
Opening frames for ceiling recessed lighting fixtures and other electrical items.					p	
Luminous ceilings.	p					Lamp strips and lamps included in electric.
Electric duct heaters (heaters installed in air ducts).				p		Line and control connections included in electric.
Electric heaters with integral fans, (unit heaters, cabinet heaters, fan coil units and the like.)				p		Line and control connections included in electric.
Electric radiators (baseboard, sill line and convector type heaters).					p	
Electric water heaters.		p				Line and control connections included in electric.
Electric boilers.				p		Line and control connections included in electric.
Through wall sleeve type air conditioning and electric heating units.					p	
Electric heater cables for radiant space heating.					p	
Electric heater cables for snow melting.					p	
Electric heater cables for mechanical system pipe tracing.					p	
Electric power consuming items and controls for same not referred to above.	p	p	p	p		Line and control connections to equipment included in electric.

Item	Oth	Plb	FP	Htg	Elec	Note
Rubbish removal.					p	Removal of the shipping and packing materials of electrical items is included in the electric regardless by whom the items are furnished.
Special tools for maintenance of equipment furnished as part of electric work.					f	

- D. Include in the electrical work all necessary supervision and the issuing of all coordination information to any other trades who are supplying work to accommodate the electrical installations.
- E. For items of equipment which are to be installed but not purchased as part of the electrical work, the electrical work shall include:
1. The coordination of their delivery.
  2. Their unloading from delivery trucks driven in to any point on the property line at grade level.
  3. Their safe handling and field storage up to the time of permanent placement in the project.
  4. The correction of any damage, defacement or corrosion to which they may have been subjected.
  5. Their field make-up and internal wiring as may be necessary for their proper operation.
  6. Their mounting in place including the purchase and installation of all dunnage, supporting members, and fastenings necessary to adapt them to architectural and structural conditions.
  7. Their connection to building wiring including the purchase and installation of all "crown boxes" or other type of termination junction boxes necessary to adapt and connect them to this wiring. Included also shall be the purchase and installation of any substitute lugs or other wiring terminations as may be necessary to adapt their terminals to the building wiring as called for and to the connection methods set forth in these specifications.
- F. Items of equipment which are installed but not purchased as part of the electrical work shall be carefully examined upon delivery to the project. Claims that any of

these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the electric work will be considered only if presented in writing within one week of the date of delivery to the project of the items in question. The electric work includes all procedures, regardless of how extensive, necessary to put into satisfactory operation, all items for which no claims have been submitted as outlined above.

## 1.12 DEFINITIONS AND INTERPRETATIONS

- A. As used in the drawings and specifications for electrical work, certain non-technical words shall be understood to have specific meanings as follows regardless of indications to the contrary in the General Conditions or other documents governing the electric work.

"Furnish" -- Purchase and deliver to the project site complete with every necessary appurtenance and support, all as part of the electrical work. Purchasing shall include payment of all sales taxes and other surcharges as may be required to assure that purchased items are free of all liens, claims or encumbrances. Payment of sales taxes is, however, specifically excluded.

"Install" -- Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project, all as part of the electrical work.

"Provide" -- "Furnish" and "install."

"New" -- Manufactured within the past two years and never before used.

Regardless of their usage in codes or other industry standards, certain words as used in the drawings or specifications for the electrical work, shall be understood to have the specific meanings ascribed to them in the following list:-

"Circuitry" -- Any electric work (not limited to light and power distribution) which consists of wires, cables, raceways, and/or specialty wiring method assemblies taken all together complete with associated junction boxes, pull boxes, outlet boxes, joints, couplings, splices and connections except where limited to a lesser meaning by specific description.

"Wiring" -- Same as Circuitry.

"Circuit" -- Any specific run of circuitry.

"Branch Circuit" -- Any light and power distribution system circuit which, at its load end, is directly connected to one or more electrical energy consuming items with no overcurrent protection devices interposed, other than (where required) those protecting the energy consuming items from overloading or overheating.

"Appliance Panel" -- Any panel, used in a light and power distribution system, containing single pole and/or multipole branches rated in various sizes.

"Lighting Panel" -- Any panel used in a light and power distribution system, having all (or the majority) of its branches single pole and rated the same.

"Lighting and Appliance Branch Circuitry" -- All or any portion of branch circuits outgoing from a lighting or appliance panel.

"Feeder" -- Any item of light and power circuitry used in a distribution system which is not lighting and appliance branch circuitry.

"Main Feeder" -- Any feeder which, at its supply end, is connected through its own overcurrent protection (and switching) device, and none other, directly to a main service or a main service overcurrent protection (and switching) device.

"Branch Feeder" -- A feeder, other than a main feeder, which complies with the definition of a branch circuit.

"Submain Feeder" -- Any feeder which is neither a main feeder nor a branch feeder.

"Distribution Panel" -- Any panel, used in a light and power distribution system, containing only multi-pole branches and with all (or the majority) of its branches used for feeders supplying other panels.

"Power Panel" -- Same as distribution panel, except with all (or the majority) of its branches used for feeders which do not supply other panels.

"Motor Power Circuit" -- Any circuit which operates nominally at 100 volts or more, and which carries electrical input energy to a motor.

"Motor Control Circuit" (used in conjunction with a motor for which a magnetic starter is supplied) -- Any circuit (other than a motor power circuit), which operates nominally at 100 volts or more, and which carries current intended for directing or indicating the performance of a motor starter.

"Motor Control Circuit" (used in conjunction with a motor for which a manual starter is supplied) -- Any circuit containing an extension of power circuit wires, other than those constituting the direct connection between source of supply, starter and motor.

"Motor Control Actuating Device" -- Any device which performs a switching function in a motor control circuit (pushbuttons, automatic contacting devices, etc.).

"Motor Control Actuated Device" -- Any device which functions in response to voltage received from a motor control circuit (pilot lights, solenoids, etc.)

"Package Unit" -- An item of equipment having one or more motors or other electric

energy consuming elements integrally factory mounted on a single base, complete with all associated control devices and interconnecting wiring.

"Low Voltage" -- Below 50 volts.

"Process Control System" -- An overall control and/or logging system of a low voltage, electronic or pneumatic type available as a fully installed "package" from specialty manufacturers (commonly referred to as a "Temperature Control System" or an "Automatic Control System" or a "Building Management System" where used in conjunction with air conditioning).

"Grade Slab" -- A building floor slab which is in contact with or directly over grade (earth).

"Building Confines" -- The extent of a building, as defined by the outside surfaces of its peripheral walls, the top surface of its roof, and the underside surface of its grade slab.

"Distribution Switch" -- Any switch used in a light and power system other than a tumbler, toggle or specialty switch in the "wiring device" category.

"Normal Electric Work Conditions" -- Locations within building confines which are neither damp, wet nor hazardous and which are not used for air handling.

"Underground" -- Subsurface and exterior to building foundations.

"At Underside of Grade Slab" -- Under a grade slab and integrated into it.

"Below Grade Slab" -- Under a grade slab but not integrated into it.

"Standard" (as applied to wiring devices) -- Not of a separately designated individual type.

"Raceway" -- Any pipe, duct, extended enclosure, or conduit (as specified for a particular system) which is used to contain wires, and which is of such nature as to require that the wires be installed by a "pulling in" procedure.

"Specialty Cast-in-Floor Raceway" -- Underfloor duct, cellular deck and the like.

"Concealed" (as applied to circuitry) -- Covered completely by building materials, except for penetrations (by boxes and fittings) to a level flush with the surface as necessitated by functional or specified accessibility requirements.

"Exposed" (as applied to circuitry) -- Not covered in any way by building materials.

"Subject to Mechanical Damage" -- Exposed within seven feet of the floor in mechanical rooms, vehicular spaces, or other spaces where heavy items (over 100 pounds) are moved around or rigged as a common practice or as required for replacement purposes.

"Primary" (as applied to light and power distribution) -- Over 600 volts.

"Secondary" (as applied to light and power distribution) -- Under 600 volts.

"Assembly" -- A defined set of elements of electric work.

- B. The following shall be treated as damp or wet locations within building confines, regardless of whether or not a high ambient moisture level is found to exist:-
  - 1. Spaces where any designations indicating weatherproof (WP) or vapor-proof (VP) appear on the drawings.
  - 2. Cooling tower areas.
  - 3. Below waterproofing in slabs applied directly on grade.
  - 4. Kitchens up to a height of 18" above finished floor.
  - 5. Outside of waterproofing in foundation walls in contact with grade.
  - 6. Above waterproofing in slabs having no building above.
  - 7. Above waterproofing in fill on slabs having no building above.
  - 8. Spaces containing equipment owned and/or maintained by the electric utility company.
- C. Electric work in slabs, walls or suspended ceilings which bound on a space defined as a damp or wet location shall meet the damp or wet location requirements if it enters into, or opens into the damp or wet location in any way.
- D. Where the word "conduit" is used without specific reference to type, it shall be understood to mean "raceway".
- E. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any electrical item in the drawings and specifications for electrical work carries with it the instruction to furnish, install and connect the item as part of the electrical work regardless of whether or not this instruction is explicitly stated.



- F. It shall be understood that the specifications and drawings are complementary and are to be taken together for a complete interpretation of the work. Where there are conflicts between the drawings and specifications or within the specifications or drawings themselves, the items of higher standard shall govern.
- G. To the extent that they govern the basic work, the specifications also govern change order work if any.
- H. No exclusion from or limitation in, the symbolism used on the drawings for electrical work or the language used in the specifications for electrical work shall be interpreted as a reason for omitting the appurtenances or accessories necessary to complete any required system or item of equipment.
- I. The drawings for electrical work utilize symbols and schematic diagrams which have no dimensional significance. The work shall, therefore, be installed to fulfill the diagrammatic intent expressed on the electrical drawings, but in conformity with the dimensions indicated on the final working drawings, field layouts and shop drawings of all trades. In particular, information as to the exact size, location and electrical connection points for mechanical equipment shall be derived by reference to HVAC and Plumbing documents.
- J. Certain details appear on the drawings for electrical work which are specific with regard to the dimensioning and positioning of the work. These are intended only for general information purposes. They do not obviate field coordination for individual items of the indicated work.
- K. Information as to general construction and architectural general construction and architectural features and finishes shall be derived from structural and architectural drawings and specifications only.
- L. The use of words in the singular shall not be considered as limiting where other indications denote that more than one item is referred to.
- M. Ratings of devices, materials and equipment specified without reference to specific performance criteria shall be understood to be nominal or nameplate ratings established by means of industry standard procedures.
- N. The restriction of conductors in wires to copper, as specified elsewhere, shall be understood to also apply to all conductors (wire, cable or bus as applicable), including those provided as part of factory assembled components such as transformers, switchboards, panelboards, switchgear, overcurrent protection and switching devices. This restriction shall apply equally to all such equipment regardless of indications (or lack thereof) elsewhere to the contrary. Aluminum will not be acceptable.

## PART 2 - PRODUCTS

### 2.1 TOUCH UP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

### 2.2 ACCESS DOORS IN FINISHED CONSTRUCTION

- A. Access doors as required for operation and maintenance of concealed equipment, valves, controls, etc. will be coordinated by general contractor.
  - 1. Access doors shall be of ample size, minimum of 16 inches x 16 inches (40 cm. x 40 cm.).
- B. Furnish (confirm with GC) access doors as required for operation and maintenance of concealed equipment, valves, controls, etc., and coordinate their delivery with the installing Trade.
  - 1. Coordinate and prepare a location, size, and function schedule of access required and deliver to a representative of the installing Trade.
  - 2. Doors shall be minimum size 16 inches x 16 inches (40 cm. x 40 cm.) as manufactured by Karp Associates, Inland Steel Products "Milcor", "MIFAB" or other approved in accordance with the following schedule:

Location	Type	Catalog Number
Plaster Ceiling	Recessed Door Panel	Karp DSC-210-PL Milcor Style AP MIFAB-CAD-PL
Acoustic Tile Ceiling	Recessed Door Panel for Tile	Karp DSC-210 Milcor Style AT MIFAB-CAD
Plaster Wall	Flush Door Panel	Karp DSC-214-PL Milcor Style K MIFAB-CAD-PL-PL
Drywall	Flush Door Panel	Karp DSC-214-M Milcor Style DW MIFAB-MDW
Drywall	Recessed Door Panel	Karp-RDW-210 MIFAB-CAD-FL

Ceramic Tile Walls	Flush Door Panel	Karp DSC-214-M Milcor Style M MIFAB-UA
Masonry Wall	Flush Door Panel	Karp DSC-214-M Milcor Style M MIFAB-UA
3-Hour Rated Masonry Shaft	Flush Door Panel	Karp DSC-211-FRT MIFAB-MPFR-SD
1-1/2 Hour Rated Shaft	Flush Door Panel	Karp KRP-150-FR Milcor Fire Door Rated Access Door Panel MIFAB-MPFR

3. Doors and frames shall be given a factory prime coat of corrosion resistant paint.
4. Type shall be as approved by Architect.
5. Frames shall be welded minimum 14 gauge steel, mitered corners ground smooth with anchors.
6. Finish shall be as selected and approved by Architect.
7. Doors shall be minimum 14 gauge steel, heavy hinges flush with frame, invisible when closed.

### PART 3 - EXECUTION

#### 3.1 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 16 for rough-in requirements.

#### 3.2 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
  1. Coordinate electrical systems, equipment, and materials installation with other building components.
  2. Verify all dimensions by field measurements.

3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
  4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
  5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
  6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
  7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
  8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
  9. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
  10. Coordinate location of access panels or doors where outlet boxes, junction boxes, or equipment are concealed behind finished surfaces.
  11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
- B. Coordinate electrical service connections to components furnished by utility companies.
1. Coordinate installation and connection of exterior underground and overhead utilities and services.
  2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- C. Locations of all devices, fixtures, and other visible components shall be as indicated on the architectural drawings. Mounting heights shall be as specified in Division 16 Section "Raceways and Boxes".

- D. Each piece of mechanical equipment located outside the building or on the roof shall be within 25 feet (7 m) of a duplex outlet. Where necessary to meet this criteria, provide duplex outlets in addition to those devices shown on the drawings. Each shall be complete with waterproof cover and integral GFI protection, and 20 ampere circuitry to the nearest 120 volt panel on the proper electric meter.

### 3.3 FIRESTOPPING

- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Firestopping."

### 3.4 FOUNDATIONS

- A. General
  - 1. All equipment, including but not limited to Switchgear, Switchboards, Motor control centers, Generators, Uninterruptible power supplies and battery racks, Automatic transfer switches, transformers shall be provided with foundations.
  - 2. Furnish shop drawings showing adequate concrete reinforcing steel details and templates for all concrete foundations and supports, and all required anchor bolts and other appurtenances necessary for the proper installation of this equipment. All concrete work shall be shown in detail on the shop drawings, prepared by this trade.
  - 3. Each piece of equipment shall be set on a concrete base minimum 4 inches (10 cm.) high and extending 3 inches (8 cm.) beyond the equipment in all directions. Bases shall be integrally keyed to structural slab.

### 3.5 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 1 Section "Cutting and Patching." In addition to the requirements specified in Division 1, the following requirements apply:
  - 1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
    - (a) Uncover Work to provide for installation of ill-timed Work.
    - (b) Remove and replace defective Work.

- (c) Remove and replace Work not conforming to requirements of the Contract Documents.
  - (d) Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.
- 2. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- 3. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers.
- B. Identify for future use with a tag at each unterminated end all low voltage (audio, data, Class 2, Class 3, PLTC, fire alarm, optical fiber, communications, coaxial, and network) cables.

### 3.6 REFINISHING AND TOUCH UP PAINTING

- A. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
- B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
- C. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
- D. Repair damage to PVC or paint finishes with matching touch up coating recommended by manufacturer.

### 3.7 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
  - 1. Cutting and patching for electrical construction.
  - 2. Touch up painting.

### 3.8 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 16050

**NEW PASSENGER TERMINAL  
DULUTH INTERNATIONAL AIRPORT  
DULUTH, MINNESOTA**

**SECTION 16060 - GROUNDING AND BONDING**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.
- B. Related sections include the following:
  - 1. Division 16 Section "Conductors and Cables."
  - 2. Division 16 Section "Raceways and Boxes."
  - 3. Division 16, Section "Underground Ducts and Utility Structures."
  - 4. Division 16, Section "Lightning Protection."

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
  - 1. Ground rods, connectors, exothermic welds, ground bars, grounding conductors and other components of system.
- B. Field Test Reports: Written reports specified in Part 3.

**1.4 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by Underwriters Laboratories, Inc.
- B. Comply with UL 467.
- C. Comply with NFPA 70, as amended by state and local codes.
- D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.
- E. Comply with applicable BICSI standards.

## F. Comply with ANSI/IEEE 142

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
1. Erico Products, Inc.
  2. Ideal Industries, Inc.
  3. Kearney.
  4. O-Z/Gedney Co.
  5. Raco, Inc.
  6. Thomas & Betts, Electrical

## 2.2 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 16 Section "Conductors and Cables."
- B. Material: Copper
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape - alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- E. Grounding Electrode Conductors: Stranded cable.
- F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- G. Bare Copper Conductors: Comply with the following:
1. Solid Conductors: ASTM B 3.
  2. Assembly of Stranded Conductors: ASTM B 8.
  3. Tinned Conductors: ASTM B 33.
- H. Copper Bonding Conductors: As follows (except where otherwise indicated):
1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 0.25-inch (6.4 mm) in diameter.
  2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.



3. Bonding Jumper: Bare copper tape, braided bare copper No. 30 AWG conductors, terminated with copper ferrules; 1.625 inch (42 mm) wide and 1/16 inch (1.5 mm) thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper No. 30 AWG conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.
- I. Grounding Bus: Bare, annealed copper bars of rectangular cross section, 1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with mounting insulators.

## 2.3 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Connectors: Bolted-pressure-type connectors, or compression type.
- C. Bolted Clamps: Heavy-duty type.
- D. Pressure Connectors: High-conductivity-plated units.
- E. Main Grounding System - Welded Connections: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions for the specific types, sizes, and combinations of conductors and other items to be connected.
  1. Manufacturer: Erico "Cadweld" system.

## 2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core.
  1. Size: 3/4 inch by 10 feet (19 by 3000 mm ).

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Equipment Grounding Conductor Application: Comply with NFPA 70, as amended by state and local codes, for sizes and quantities of equipment grounding conductors except where specific types, larger sizes or more conductors are indicated.
  1. Provide equipment grounding conductors with circuit conductors for all feeders and branch circuits.

- B. Signal and Communications: For telephone, alarm, voice and data and other communication systems, provide a #4 AWG minimum green insulated copper conductor in raceway from the grounding electrode system to each service location, antenna, terminal cabinet, wiring closet and central equipment location.
- C. The ground bus of switchboards and switchgear shall be connected to the main grounding electrode by means of insulated grounding electrode conductors run in intermediate metallic conduit and sized as per Code.
- D. The neutral bar of each individually enclosed service switch shall be bonded to its enclosure on the line side of a removable link (included therein), and connected to the main grounding electrode by means of insulated grounding electrode conductors run in intermediate metallic conduit and sized as per Code.
- E. The emergency generator system neutral shall be grounded by means of a connection from the [neutral bar in the generator main circuit breaker enclosure to the main grounding electrode by means of an insulated grounding electrode conductor run in intermediate conduit and sized as per Code. Include a bonding connection from the neutral to the equipment enclosure.
- F. The Uninterruptible Power Source (UPS) system neutral shall be grounded by means of a connection from the neutral bar in the UPS main circuit breaker enclosure to the main grounding electrode by means of an insulated grounding electrode conductor run in intermediate conduit and sized as per Code. Include a bonding connection from the neutral to the equipment enclosure.
- G. The main grounding electrode shall be an accessible point on the nearest metallic main water service pipe. Connection shall be made on the street side of the main valve utilizing a ground clamp of a type specifically manufactured for the purpose. Bonding jumpers shall be provided around the water meters (if provided) and around insulating joints and/or sections, utilizing conductors sized as per Code and run in IMC. Bond the structural steel to the grounding electrode system.
- H. The water pipe ground shall be supplemented by an additional "made" electrode consisting of buried ground rods, and provided in sufficient quantity so as to have a measured resistance to ground of not more than 5 ohms. Establish a bonding connection from the "made" electrode consisting of green insulated conductors run in IMC and sized as per Code.
- I. Bond the reinforcing bars in concrete to the nearest grounding electrode. Where reinforcing bars are installed in building foundations and footings protect the bonding conductor during construction. Arrange for inspection by the authority having jurisdiction prior to placement of concrete.
- J. The neutral of secondary winding of each low voltage (i.e., less than 600 volts) transformer shall be grounded to the grounding electrode as specified hereinafter by means of an insulated grounding conductor sized as per Code and run in IMC. The neutral of each transformer shall be bonded to the transformer enclosure by means of an insulated conductor sized as per code. If not factory installed the jumper shall be field installed within the transformer enclosure.

- K. At each secondary voltage to secondary voltage transformer, bond the metallic water piping system to the transformer neutral at the nearest available location utilizing conductors sized equal to the grounding electrode conductor and run in conduit.
- L. The grounding electrode for each low voltage (both windings 600 volts or less) transformer shall be the main water service pipe entering the building taken at a point on the street side of its main valve. Utilize a common ground clamp on the main water pipe, with means for connecting the multiple separate grounding conductors from the various transformers. In lieu of multiple separate grounding conductors, multiple connection to a "ground bus cable" may be utilized. The ground bus cable shall consist of a 500 MCM green coded insulated copper conductor run in 1-1/2 inch (DN 41) threaded steel conduit from the street side of the main water service valve, throughout the building to all dry type transformer locations requiring grounding. The ground bus cable shall be connected to the main water pipe by means of a ground clamp of a type specifically manufactured for the purpose. At each transformer location, establish a "grounding electrode" connection point by arranging a break in the "ground bus cable" conduit exposing the cable for not more than a twelve inch length. Ends of conduit at the break shall be equipped with bushings. The connection shall be made by means of an irreversible compression connector listed for the purpose or an exothermic weld.
- M. Include a properly sized green insulated grounding conductor within the conduit for each feeder supplying a panel containing an isolated ground bus (i.e., insulated from ground). Increase indicated conduit size if necessary to accommodate this conductor. Connect to the neutral grounding facility for feeders originating at the service entry point or at 480-120/208 volt stepdown transformers as applicable.
- N. Bond metallic conduits containing grounding electrode conductors and main bonding conductors to the ground bus service enclosure and/or grounding electrode at both ends of each run utilizing grounding bushings and jumpers. Bonding jumpers shall be sized equal to the grounding electrode conductors.
- O. Provide grounding bonds for all metallic conduits of the light and power system which terminate at (or in pits below) distribution equipment for which a ground bus is specified. Accomplish this by equipping the conduits with bushings of the grounding type connected individually to the ground bus.
- P. Provide supplementary ground bonding to maintain continuity of the equipment and raceway grounding system as follows:
  - 1. Bonding jumpers shall be applied where wiring devices (receptacles and switches) are not equipped with approved self-grounding features. Include any necessary field modifications for termination of the bonding jumpers so as to insure grounding continuity.
  - 2. Bonding jumpers shall be applied to insure that grounding continuity does not depend solely on the supporting screws fastening metallic enclosures together.
  - 3. Include any necessary field modifications for termination of the bonding jumpers so as to insure grounding continuity.

- Q. Provide grounding of raised metallic floors used to contain wiring to computers and/or other equipment. Where the floor system is of a type that is specifically designed by the manufacturer to maintain ground continuity through its metallic structural support system, the grounding may be accomplished by means of no fewer than (8) bonding connections spaced equally about the perimeter but in no case more than 100 feet (30 m) apart. Utilize #8 AWG green insulated copper conductors for the connection of the bonding locations to the ground bus in the panel serving the equipment and the service ground point. If the raised floor is to be used as an air handling plenum, the insulation shall be of a fluoropolymer type suitable for use in plenums without raceway. If the floor system is not designed to maintain ground continuity through the metallic structural support system, alternating support pedestals in each direction must be connected to the bonding conductors.
- R. Provide a ground connection for each 100 feet (30 m) of run of cable tray, and for each isolated run of less than 100 feet (30 m), by means of a #6 AWG green coded insulated copper conductor run in 3/4 inch (DN 21) conduit. The grounding electrode for each run of cable tray requiring same shall consist of a cadweld connection to adjacent structural steel at a point where only fireproofing and not structural concrete is applied to it or the nearest cold water pipe if steel is not available. Utilize ground clamps of a type specifically manufactured for the purpose.
- S. Provide supplementary ground bonding for each motor control center (MCC) as follows:
1. Provide equipment grounding conductors as required to insure that all sections (including attached integral or field installed pullboxes) are bonded together by means of these conductors and by means of the MCC ground bus (if a ground bus is included in the MCC).
  2. Provide grounding bushings and jumpers as required to insure that all conduits and any contained equipment grounding conductors are bonded to the enclosure grounding conductors (or ground bus).
- T. Where specifically noted on the drawings, or described hereinbefore in this Section, include insulated equipment and raceway grounding conductors run within the raceways. Where insulated equipment grounding conductors required for feeders have not been included in the quantities of conductors indicated on the drawings, incorporate such conductors in accordance with the electrical code. Adjust conduit sizing if required.
- U. Common Ground Bonding With Lightning Protection System: Bond electric power system ground directly to lightning protection system grounding conductor at closest point to electric service grounding electrode. Use bonding conductor sized same as system ground conductor and installed in conduit.
- V. Grounding Underground Distribution System Components complies with IEEE C2 grounding requirements and the following. Provide additional grounding if required to comply with Utility Company standards.

1. **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, non-shrink grout.
2. **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, hard-drawn 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.
3. **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 pad mounted equipment 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.

### 3.2 INSTALLATION

- A. **General:** Ground electrical systems and equipment according to NFPA 70, as amended by state and local codes, except where Drawings or Specifications exceed such requirements.
- B. **Grounding Rods:** Locate a minimum of 1-rod length from each other and at least the same distance from any other grounding electrode.
  1. Drive until tops are 2 inches (50 mm) below finished floor or final grade, except as otherwise indicated.
  2. Interconnect with grounding-electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make these connections without damaging copper coating or exposing steel.
- C. **Grounding Conductors:** Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- D. **Underground Grounding Conductors:** Use bare copper wire. Bury at least 24 inches (600 mm) below grade.

- E. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, 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 by grounding-clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Provide a grounding jumper with the same size conductor across dielectric fittings. Bond grounding-conductor conduit to conductor at each end.
- F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding-clamp connectors.
- G. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

### 3.3 CONNECTIONS

- A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
  - 2. Make connections with clean, bare metal at points of contact.
  - 3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.
- E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.
- F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

- G. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage an independent electrical testing organization to perform tests described below.
- B. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal.. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the 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. Perform tests by the fall-of-potential method according to IEEE 81.
- C. Maximum grounding resistance shall be less than or equal to 5 ohms.
- D. Excessive Ground Resistance: Where resistance to ground exceeds specified values, provide additional grounding to achieve required results.
- E. Report: Prepare test reports, certified by the testing organization, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results.
- F. Field Test Reports: Submit written test reports to include 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.

END OF SECTION 16060

**NEW PASSENGER TERMINAL  
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**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 electrical identification materials and devices required to comply with ANSI C2, NFPA 70 - as amended by state and local codes, OSHA standards, and the requirements of the authorities having jurisdiction. All power distribution equipment shall be labeled.

**1.3 SUBMITTALS**

- A. Product Data: For each electrical identification product indicated.
- B. Schedule of Nomenclature: An index 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 NFPA 70, as amended by state and local codes.
- B. Comply with ANSI A13.1 and NFPA 70 for color-coding.
- C. Comply with ANSI Z535-2, Z535-4, and NFPA 70E.
- D. Comply with ANSI C2.
- E. 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 CABLE LABELS

- A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
  - 1. Color: Black letters on orange field.
  - 2. Legend: Indicates voltage and service.
- B. 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.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored 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.
- E. 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, or embossed 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.
- E. Write-On Tags: Polyester tag, **0.015 inch (0.38 mm)** thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

## 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, NAMEPLATES AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Engraved Plastic Warning Labels, Nameplates and Signs: Engraving stock, melamine plastic laminate, 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.
- C. Baked-Enamel Warning Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. **1/4-inch (6.4-mm)** grommets in corners for mounting. Nominal size, **7 by 10 inches (180 by 250 mm)**.
- D. Exterior, 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 **48 INCHES (1200 MM)**.". Adjust clearance dimensions as required for system voltage and equipment configuration.
  3. Arc Flash Warning: "POTENTIAL ARC FLASH HAZARD - APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT AND TOOLS REQUIRED WHEN WORKING ON THIS EQUIPMENT."

- F. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

## 2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
1. Minimum Width: 3/16 inch (5 mm).
  2. Tensile Strength: 50 lb (22.3 kg) minimum.
  3. 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: Formulated for the type of surface and intended use.
1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
  2. Primer for Concrete Masonry Units: Heavy-duty concrete masonry unit block filler.
  3. Primer for Concrete: Exterior concrete and masonry primer.
  4. Enamel: Exterior semigloss acrylic enamel.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands or with snap-around, color-coding bands:
1. Fire Alarm System: Red.
  2. Telecommunication System: Green and yellow.
  3. Control Wiring: Green and red.
- B. 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 aluminum wraparound marker labels or non-ferrous metal tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

- C. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use aluminum wraparound marker labels. Identify each ungrounded conductor according to source and circuit number.
- D. Ground fault interrupter outlets: Identify receptacles supplied by ground fault interrupter circuit breakers or by upstream ground fault interrupter receptacles. Use engraved letters on device plate.
- E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.
- F. 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.
- G. 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.
- H. Warning Labels for Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
  - 1. 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.
  - 3. Switchboards, Panelboards, Equipment Control Panels, Meter Socket Enclosures, and Motor Control Centers: Labeled to warn of potential electric arc flash hazards. The label shall be located so as to be clearly visible before examination, adjustment, servicing, or maintenance of the equipment.

I. 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.
2. 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 or for load shedding.

J. 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) 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- (38-mm-)** high label; where 2 lines of text are required, use labels **2 inches (50 mm)** high.
- (b) 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.
- (l) Contactors.
- (m) Remote-controlled switches, dimmer modules, and control devices.
- (n) Battery racks.
- (o) Power-generating units.
- (p) Voice and data cable terminal equipment.
- (q) Master clock and program equipment.
- (r) Intercommunication and call system stations.
- (s) Television/audio components, racks, and controls.
- (t) Fire-alarm control panel and annunciators.
- (u) Monitoring and control equipment.
- (v) Uninterruptible power supply equipment.
- (w) 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. Attach signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- E. 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.
- F. 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.
  - 1. Color shall be factory applied the entire length of conductors, except the following field-applied color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:

- (a) Colored, pressure-sensitive plastic tape in half-lapped turns for a 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. Use **1-inch- (25-mm-)** wide tape in colors specified. Locate tape bands to avoid obscuring cable identification markings.
  - (b) Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting **3 inches (76 mm)** from the terminal and spaced **3 inches (76 mm)** apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length. Locate bands to avoid obscuring cable identification markings.
- 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.
- G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- 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: Install painted identification according to manufacturer's written instructions and as follows:
  - 1. Clean surfaces of dust, loose material, and oily films before painting.
  - 2. Prime surfaces using type of primer specified for surface.

END OF SECTION 16075

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**SECTION 16080 - ELECTRICAL TESTING**

**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 general requirements for electrical field testing and inspecting. Detailed requirements are specified in each Section containing components that require testing. General requirements include the following:
  - 1. Coordination requirements for testing and inspecting
  - 2. Reporting requirements for testing and inspecting.

**1.3 QUALITY ASSURANCE**

- A. As specified in each Section containing electrical testing requirements.

**PART 2 - PRODUCTS**

NOT USED

**PART 3 - EXECUTION**

**3.1 GENERAL TESTS AND INSPECTIONS**

- A. Where no specific requirements are given, provide testing in accordance with the latest version of the InterNational Testing Association (NETA) Acceptance Testing Specification for Electric Power Distribution Equipment and Systems.
- B. Where tests are specified to be performed by an independent testing agency, prepare systems, equipment, and components for tests and inspections, and perform preliminary tests to ensure that systems, equipment, and components are ready for independent agency testing. Include the following minimum preparations as appropriate:
  - 1. Perform insulation-resistance tests.
  - 2. Perform continuity tests.
  - 3. Perform rotation test (for motors to be tested).



4. Provide a stable source of single-phase, 208/120-V electrical power for test instrumentation at each test location.
- C. Test and Inspection Reports: In addition to requirements specified elsewhere, report the following:
1. Manufacturer's written testing and inspecting instructions.
  2. Calibration and adjustment settings of adjustable and interchangeable devices involved in tests.
  3. Tabulation of expected measurement results made before measurements.
  4. Tabulation of "as-found" and "as-left" measurement and observation results.

### 3.2 COMMISSIONING

- A. Provide manpower as required to assist the commissioning agent, as required in Division 1 Section "GENERAL COMMISSIONING REQUIREMENTS" and Division 1 Section "HVAC COMMISSIONING REQUIREMENTS".

END OF SECTION 16080

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**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 splices, connectors, and terminations for wiring systems rated 600 volts and less.

**1.3 SUBMITTALS**

- A. Product Data: for each type of product indicated.
- B. Field Quality Control Test Reports.

**1.4 QUALITY ASSURANCE**

- A. Listing and Labeling: Provide products specified in this Section that are Underwriters Laboratories listed and labeled.
  - 1. The Terms "Listed and Labeled": As defined in the "National Electrical Code," Article 100.
- B. Comply with NFPA 70, as amended by state and local codes.

**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.

**2.2 CONDUCTORS AND CABLES**

- A. Available Manufacturers:
  - 1. American Insulated Wire Corp.; a Leviton Company.

2. General Cable Corporation.
  3. Senator Wire & Cable Company.
  4. Southwire Company.
  5. Belden, Division Cooper Industries.
  6. Cable & Wire Division, AT&T.
  7. Pyrotenax.
- B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
1. Conductor Material: Copper, complying with NEMA WC 5 or 7; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.
  2. Conductor Insulation Types: Type THHN, THWN, XHHW complying with NEMA WC 5 or 7.
- C. Electrical Circuit Protective System Cable: Where required by code, or where indicated on the drawings, feeders and circuitry are a fire rated cable system, except where enclosed within equivalent fire rated construction indicated on the architectural drawings. Mineral-insulated, metal-sheathed cable, Type MI.

## 2.3 CONNECTORS AND SPLICES

- A. Available 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 WIRE AND INSULATION APPLICATIONS

- A. Utilize copper conductors with THWN, THHN or XHHW insulation, except provide THHW-2, THWN-2 or XHHW-2 insulation for conductors 1/0 and larger in "wet" locations. Conductors utilized in underground installations are UL Listed for use in wet locations. Conductors are run in raceways as described in Section 16 "Raceways and Boxes". Type THHW and THHW-2 are not utilized where excluded by conduit sizing. Type THWN are not utilized for connection to 100 percent rated overcurrent devices.
- B. Electrical circuit protective system cable is utilized for feeders and circuitry which is required to be fire rated and which is not enclosed within equivalent fire rated construction indicated on the architectural drawings.
  - 1. A one-hour rating is required for:
    - (a) Feeders for Emergency Systems except where run within space directly protected by sprinklers.
    - (b) Normal and emergency feeders to fire pump.
- C. In general, cable ampacities are based on a 60 degree C rating for cables #1 AWG and smaller and on a 75 degree C rating for larger cables. In conjunction with this, note the following:
  - 1. 75 degree C ratings may be utilized for cables #1 AWG and smaller where overcurrent protection and switching devices (OCD's), wiring devices and solidly connected equipment connected to such cables are listed and identified for use with 75 degree C rated conductors. (Note that these specifications require all OCD's - regardless of ampere rating to be suitable for use with 75 degree C rated conductors).
  - 2. Increase indicated cable (and raceway) sizing as required for circuitry where conductors #1 AWG and smaller will connect directly to solidly connected utilization equipment whose load current will exceed the 60 degree C rating of the cable, and for which manufacturer's approval for cable terminations is less than 75 degrees C, or to receptacles whose ampere rating exceeds the 60 degree C rating of the connected cables unless such receptacles are listed for use with 75 degree C rated conductors. Note that accessible intermediate tap boxes may be utilized adjacent to 60 degree C rated terminations to allow conductor "upsizing" locally so as to comply with such termination requirements.
- D. For low voltage systems where circuits are power limited in accordance with Class 2 or Class 3 requirements (as defined in Article 725 of the National Electrical Code) utilize cables having characteristics as follows:

1. Cables are of a fluoropolymer type having adequate fire-resistant and low-smoke producing characteristics and are U.L. listed for plenum use (Type CL2P for Class 2 circuits, type CL3P or CMP for Class 3 circuits), except that where run in conduit, they may be U.L. type CL3, or where run in cable trays they are U.L. type CMP.
- E. For low voltage systems whose circuits are not power limited Class 2 or Class 3 (in accordance with the requirements of Article 725 of the National Electrical Code), and which are not telecommunications circuitry (in accordance with Article 800 thereof), utilize copper conductors having TFN insulation for sizes #16 AWG and smaller, and type THHN or THWN for sizes #14 AWG and larger. Wires are run in electric metallic tubing.
- F. Low voltage circuits intended for the distribution of voice or data utilize communications cables (complying with requirements of Article 800 of the National Electrical Code) having characteristics as follows:
1. Cables are of a fluoropolymer type having adequate fire-resistant and low-smoke producing characteristics and are U.L. listed for plenum use (Type CMP), except that where run in conduit, they may be U.L. type CM.
  2. Refer to Division 16, Section "Fire Protective Alarm System" for fire alarm system wiring.

### 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 wires and cables according to Division 16 Section "Electrical Identification" and Division 16 Section "Supporting Devices".

### 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.
- C. Maintain all splices and joints in removable cover boxes or cabinets where they may be easily inspected.
- D. Locate each completed conductor splice or joint in the outlet box, junction box, or pull box containing it, so that it is accessible from the removal cover side of the box.
- E. Join solid conductors #8 AWG and smaller by securely twisting them together and soldering, or by using insulated coiled steel spring "wire nut" type connectors. Exclude "wire nuts" employing non-expandable springs. Terminate conductors #8 AWG and smaller by means of a neat and fast holding application of the conductors directly to the binding screws or terminals of the equipment or devices to be connected. Terminals and connectors are U.L. approved specifically for the application.
- F. Join, tap and terminate stranded conductors #6 AWG and larger by means of solder sleeves, taps and lugs with applied solder or by means of pressure indent type connectors, or mechanical connectors utilizing ball tipped set screws. Apply pressure indent type connectors, utilizing tools manufactured specifically for the purpose and having features preventing their release until the full pressure has been exerted on the lug or connector. Factory installed equipment or device terminals are of types UL approved specifically for the application.
- G. Except where wire nuts are used, build up insulation over conductor joints to a value equal both in thickness and dielectric strength to that of the factory applied conductor insulation. Insulation of conductor taps and joints are by means of half-lapped layers of rubber tape, with an outer layer of friction tape; by means of half-lapped layers of approved plastic electric insulating tape; or by means of split insulating casings manufactured specifically to insulate the particular connector and conductor, and fastened with stainless steel or non-metallic snaps or clips.
- H. Exclude splicing procedures for neutral conductors in lighting and appliance branch circuitry which utilize device terminals as the splicing points.
- I. Exclude joints or terminations utilizing solder in any conductors used for grounding or bonding purposes.
- J. Exclude all but solder or pressure indent type joints in conductors used for signaling or communications purposes.

### 3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."
- B. 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.

- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. 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.
- E. Cut sleeves to length for mounting flush with both wall surfaces.
- F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and cable unless sleeve seal is to be installed.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 7 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 7 Section "Through-Penetration Firestop Systems."
- K. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between cable and sleeve for installing mechanical sleeve seals.

### 3.5 SLEEVE-SEAL INSTALLATION

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

### 3.6 FIREPROOFING WIRES AND CABLES:

- A. Beyond the termination of raceways, apply fireproofing over the unprotected insulation and/or splices of the following:-
  - 1. All service feeder cables ahead of main service overcurrent protection devices within all the pits, cable chambers or pull boxes they pass through and elsewhere where they are not enclosed in raceways.
  - 2. Fire pump feeder cables wherever they extend beyond the termination of raceways.
  - 3. All feeder wires and cables emanating from different secondary service connections or both normal and emergency supplies which, due to indications on the drawings or unavoidable field conditions are forced to enter the same unbarriered compartment of a cable chamber, cable pit, pull box or junction box.
- B. Fireproofing of wires and cables is by means of a half-lapped layer of Scotch 77 fire and arc-proofing tape. The wrapped tape is secured by a band consisting of two layers of glass cloth electrical tape. Fireproofing is extended up into raceways. Fireproofing is applied in an overall manner to raceway groupings of conductors.

### 3.7 INSTALLATION OF CIRCUITRY FOR MISCELLANEOUS LOW VOLTAGE SYSTEMS:

- A. Comply with requirements described in applicable subsections of this Section. In particular, note the following circuitry requirements for low voltage systems:
  - 1. Wiring for miscellaneous low voltage systems may be run without conduit - subject to the approval of the local authorities - except where prohibited by other sections of these specifications or by indications on the drawings.
  - 2. Where conduit is required, it is steel electric metallic tubing (EMT), except that it is galvanized intermediate steel conduit where located within 8 feet (2.4 m) of the floor in mechanical spaces (or is otherwise exposed to mechanical damage), or is intended for embedment in concrete.
  - 3. Wires and cables have characteristics - in compliance with Articles 725 and/or 800 (as applicable) of the National Electrical Code - as described elsewhere in the specifications or drawings for this project, and are U.L. listed in accordance therewith.
  - 4. Where wires and cables are permitted to be run without conduit, they are independently supported from the building structure or ceiling suspension systems at intervals not exceeding four feet on center, utilizing cable supports specifically approved for the purpose. Wires and cables do not rest on or depend on support from suspended ceiling media (tiles, lath, plaster, as well as splines, runners or bars in the plane of the ceiling), nor are they supported from pipes, ducts or conduits. Where cables are bundled together, separate bundles are provided separately for each type of cabling and separately for each independent system. Bundling and/or supporting ties are of a type suitable for use in a ceiling air handling plenum regardless of whether or not installed in a plenum.



5. Cables are tagged or labeled at each termination point and in each intermediate junction box, pull box or cabinet through which they pass.
6. Comply with applicable requirements for locating and routing circuitry, for installing circuitry, and for fire-stopping as described in other sub-section of this Section.

### 3.8 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. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 2 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
  1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 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 splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- C. Test Reports: Prepare a written report to record the following:
  1. Test procedures used.
  2. Test results that comply with requirements.
  3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 16120

**NEW PASSENGER TERMINAL  
DULUTH INTERNATIONAL AIRPORT  
DULUTH, MINNESOTA**

**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 16 Section "Underground Ducts and Utility Structures" for exterior ductbanks, manholes, and underground utility construction.
  - 2. Division 16 Section "Basic Electrical Materials and Methods" for firestopping.
  - 3. Division 16 Section "Supporting Devices" for raceway and box supports.
  - 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 non-metallic tubing.
- C. FMC: Flexible metal conduit.
- D. IMC: Intermediate metal conduit.
- E. LFMC: Liquidtight flexible metallic conduit.
- F. RNC: Rigid nonmetallic conduit.

**1.4 SUBMITTALS**

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

## 1.5 QUALITY ASSURANCE

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

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

### 2.2 METAL CONDUIT AND TUBING:

- A. Available Manufacturers
  - 1. Alflec Corp
  - 2. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
  - 3. LTV Steel Tubular Products Company.
  - 4. Wheatland Tube Co.
  - 5. Triangle PWC, Inc.
- B. Rigid Steel Conduit: ANSI C80.1
- C. IMC: ANSI C80.6.
- D. PVC-Coated Steel Conduit: PVC-coated IMC.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- E. EMT and Fittings: ANSI C80.3.
  - 1. Fittings: Set-screw or compression.

- F. FMC: Zinc coated steel.
- G. LFMC: Flexible steel conduit with PVC jacket.
- H. Fittings: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
  - (a) Fittings for EMT: Die-cast compression type.
  - (b) Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- I. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

## 2.3 METAL WIREWAYS

- A. Available Manufacturers:
  - 1. Hoffman.
  - 2. Square D
  - 3. The Wiremold Company
- B. Material and Construction: Sheet metal sized and shaped as indicated.
  - 1. Dry locations: NEMA 250, Type1.
  - 2. Damp or Wet locations: NEMA 250, Type 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 a complete system.
- D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- E. Wireway Covers: Screw-cover type.
- F. Finish: Manufacturer's standard enamel finish.

## 2.4 SURFACE RACEWAYS

- A. Surface Metal Raceway: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating and paint finish as selected by the architect.
  - 1. Available Manufacturers:

- (a) Thomas & Betts Corporation.
  - (b) Walker Systems, Inc; Wiremold Company (The)
  - (c) The Wiremold Co., Electrical Sales Division.
- B. Types, sizes and channels as indicated and required for each application, with fittings that match and mate with raceways.

## 2.5 BOXES, ENCLOSURES AND CABINETS

- A. Available 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. Spring City Electrical Manufacturing Co.
  - 9. Thomas & Betts Corporation.
  - 10. Walker Systems Inc.; Wiremold Company (The).
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast Metal Outlet and Device Bopxes: NEMA FB 1, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Floor Boxes: Cast metal, fully adjustable, rectangular.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast Metal Pull and Junction Boxes: NEMA FP 1 cast aluminum with gasketed cover.
- 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 associated 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.

- I. Pull boxes for Telephone and Signal System Raceways: ANSI/EIA/TIA-569A

## 2.6 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: Use the following wiring methods, except as specifically noted otherwise.
  1. Exposed: Rigid steel or IMC.
  2. Concealed: Rigid steel or IMC.
  3. Underground, Single Run: RNC.
  4. Underground, Grouped: RNC.
  5. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, electric solenoid, or motor driven equipment): LFMC.
  6. Exposed within 30 feet (10 meters) chiller: PVC coated steel conduit.
  7. Boxes and Enclosures: NEMA 250, Type 3R or 4.
- B. Indoors: Use the following wiring methods:
  1. IMC for all purposes and in all applications except where specifically excluded, or where alternate methods are specified below.
  2. Normal and emergency feeders to fire pumps: Rigid steel conduit. Feeder conduit encased in 2 inches (5cm) of concrete (or other code approved equivalent) where conduits are not physically routed outside the building. Exclude concrete for jockey pumps and/or auxiliary pumps.
  3. Control circuitry to fire pumps: Rigid steel conduit.
  4. Utilize EMT for:
    - (a) Main and submain feeders.
    - (b) Branch feeders.
    - (c) Lighting and appliance branch circuitry.
  5. Exposed lighting and appliance branch circuitry runs in finished spaces : Surface metal raceway.

6. Refer to appropriate Sections of Division 16 for additional requirements relating to wiring methods for control/signal transmission, fire alarm systems, telecommunications, and other communication and alarm system distribution.
7. Wiring methods listed above shall be restricted as follows:
  - (a) Exclude EMT from concrete embedment, from locations where subject to mechanical damage and from exposed locations in finished spaces.
  - (b) Exclude surface metal raceway from concealed installations, from locations where subject to mechanical damage and from wet or damp locations.
  - (c) Utilize only intermediate or rigid steel conduit from runs in (or opening into) hazardous areas. Comply with electric code requirements regarding sealing fittings, boxes, enclosures as appropriate for the conditions of atmospheric contamination.
8. The following shall be treated as damp or wet locations within building confines, regardless of whether or not a high ambient moisture level is found to exist:
  - (a) Spaces where any designations indicating weatherproof (WP) or vaporproof (VP) appear on the drawings.
  - (b) Parking garage areas.
  - (c) Loading docks.
  - (d) Chiller areas.
  - (e) Below waterproofing in slabs applied directly on grade.
  - (f) Kitchens up to a height of 18 inches (45 cm) above finished floor.
  - (g) Outside of waterproofing in foundation walls in contact with grade.
  - (h) Above waterproofing in slabs having no building above.
  - (i) Above waterproofing in fill on slabs having no building above.
  - (j) Spaces containing equipment owned and/or maintained by the electric utility company.
  - (k) Electric work in slabs, walls or suspended ceilings which bound on a space defined as a damp or wet location shall meet the damp or wet location requirements if it enters into, or opens into the damp or wet location in any way.

- (l) Tug ramps, tug tunnels and other similar areas.
9. The following shall be interpreted as being "hazardous" locations regardless of actual condition of atmospheric contamination.
- (a) The entire floor to ceiling volume of space where any designations indicating "explosion proof" (EP) are shown.
  - (b) Gas meter rooms.
  - (c) The volume included between the floor and a height of 18 inches (45 cm) above the floor throughout all space designated for parking, including all associated above grade vehicular ramps and access ways, and all spaces on the floor not separated from the parking space by partitions.
  - (d) The entire floor to ceiling volume of all spaces designated for the storage of flammable anesthetics.
  - (e) The volume included between the floor and a height of 60 inches (150 cm) above the floor throughout all spaces designated for the administration of flammable anesthetics.
  - (f) The entire interior volume of any paint spray booth and its associated ductwork.
  - (g) The entire volume of any space falling within 20 feet (6 meters) of the open face of any paint spray booth, and which is not cut off by air tight, unpierced walls, partitions, slabs or other general construction elements.
  - (h) The entire floor to ceiling volume of any space designated for painting by means of open spraying or tank dipping.
  - (i) Electric work located in slabs, walls or suspended ceilings which bound on a space defined as a hazardous location shall meet the hazardous location requirements if it enters into, or opens into, the hazardous location in any way.
- C. Minimum Raceway Size: 3/4 inch (DN 21) trade size.
- D. Indicated Raceway Size: Raceway sizes indicated are based on non-flexible conduit. Where flexible type raceways are specified, increase raceway size as required to maintain code mandated maximum conduit fill.
- E. Raceway Fittings: Compatible with raceways and suitable for use and location.
- 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
  - 2. EMT: Where embedded in concrete, utilize concrete compression type couplings, connectors and fittings of a type which assures ground continuity.



3. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

### 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 raceway as specified in Division 16 Section "Supporting Devices."
- D. Install temporary closures to prevent foreign matter from entering raceway.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- F. Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
- 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. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much 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.
- I. Join raceways with fittings designed and approved for the purpose and make joints tight.
  1. Use insulating bushings to protect conductors.
- J. Tighten set screws of threadless fittings with suitable tool.
- K. Equip all raceways, including those embedded in concrete which cross building expansion or control joints, with expansion fittings having flexible grounding bonds bypassing sliding parts. Arrange expansion fittings on concrete embedded raceways so that sliding action is not impeded.

L. Terminations:

1. Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box. Use two locknuts, one inside and one outside box.
2. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

M. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb (90 kg) tensile strength. Leave not less than 12 inches (300 mm) of slack at each end of the pull wire.

N. Telephone and Signal System Raceways 2-Inch Trade Size (DN 53) and Smaller: In addition to the above requirements, install in maximum lengths of 100 feet (30 m) and with a maximum of two 90-degree bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements. Pull or junction boxes shall be sized in accordance with ANSI/EIA/TIA-569A guidelines.

O. Install raceway sealing fittings according to the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:

1. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
2. Where otherwise required by the NFPA70.

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 6 feet (1.8 m) of FMC for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in wet or damp 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. Install hinged cover enclosures and cabinets plumb. Support at each corner.
- U. Raceways Embedded in Slabs: Embedment of circuitry in field poured concrete slabs and fill will be permitted subject to the approval of the structural engineer, compliance with the "pour schedule" established for the project, and to the following criteria:
  1. They shall be routed in such a manner as to coordinate with the structural requirements of the building. Submit proposed routing to structural engineer for approval. Raceways proposed to be embedded in concrete which are not approved by the structural engineer shall be installed in another manner (in accordance with these specifications).
  2. Note that embedment of conduit in field poured concrete slabs and/or fill will not be permitted in tenant areas and other spaces where the location of all electrical lighting, power and signal outlets are not shown on the electrical drawings.
  3. Maximum outside diameter of raceways shall not exceed one third of concrete thickness. Raceways shall be run in a "single layer" with their outside surface no closer than 1 inch (25mm) to any surface of the concrete.
  4. Install in middle 1/3 of slab thickness.
  5. Provide support for raceways independent of reinforcing rods.
  6. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
  7. Space raceways laterally to prevent voids in the concrete.
  8. Run raceway larger than 1 inch (DN 27) trade size parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place raceway close to slab support.
  9. They shall not be spaced closer than 3 diameters on center, with a minimum of 3 inches (75mm) between the outside surfaces of the raceways, except at tees, crosses or other single level wide angle junction points.
  10. Where crossovers or close groupings are unavoidable, circuitry shall either be dog-legged out of the concrete or be carefully field coordinated so as not to cause structural weakness. Where in metal deck or subfloor type of construction, crossovers shall occur only in valleys.
  11. Where turned up or down into a wall or partition they shall, before entering same, be routed parallel for a long enough distance to assure that no relocation of the wall or partition will be necessary to conceal the required bend.
  12. They shall be routed in accordance with field instructions issued by the Architect where such instructions differ from specifications set forth herein.

- V. To the extent that circuitry cannot be embedded in concrete slabs and fill, floor and wall mounted outlets shall be supplied in conformance with so-called "poke through system" criteria as described below. Outlets supplied from a specialty cast-in-floor raceway system constitute an exception to this criteria.
- W. Criteria for the "poke through" system of circuitry are as follows:-
  - 1. Circuitry shall be run in the hung ceiling space of the story which it serves or in the hung ceiling space of the story immediately below, utilizing openings cut through the floor slab when necessary.
  - 2. The running of circuitry, at the story below the one served, shall be held to an absolute minimum, and shall be used only for tying floor outlets to their nearest adjacent outlets or for other such unavoidable purposes.
  - 3. Circuitry serving a given story shall emanate from local supply or central facilities on the same story and none other.
  - 4. Openings through floor slabs shall be cut, patched and "firestopped" as part of the electrical work. "Firestopping" shall include the filling in of excess opening spaces as well as the utilization of approved, fire-rated through-floor fittings for all floor outlets. These fire-rated fittings shall each be of the "dual service" type, complete with integral floor stanchion which can accommodate 120 volt and telephone and/or signal) circuitry and devices. All "firestopping" shall be performed as directed in the field. General instructions establishing cutting, patching and "firestopping" separate from the electric work are not applicable to the poke through system of circuitry.
  - 5. Openings through floor slabs shall not be spaced closer together than 2 feet (61 cm), and no more than one fire-rated fitting per 65 square feet (6 square meters) of floor area in each span shall be utilized.

### 3.3 LOCATING AND ROUTING CIRCUITRY:

- A. All circuitry shall be run concealed except that it shall be run exposed:-
  - 1. Horizontally at the ceiling of permanently unfinished spaces which are not assigned to mechanical or electrical equipment.
  - 2. Horizontally and vertically in mechanical equipment spaces.
  - 3. Horizontally and vertically in electric equipment rooms.
  - 4. Where specifically noted on the drawings.
- B. Concealed circuitry shall be so located that building construction materials can be applied over its thickest elements without being subject to spalling or cracking.

### 3.4 INSTALLING JUNCTION, PULL AND OUTLET BOXES:

#### A. Apply junction and pull boxes in accordance with the following:-

1. Include pull boxes in long straight runs of raceway to assure that cables are not damaged when they are pulled in.
2. Include junction and pull boxes to assure a neat and workmanlike installation of raceways.
3. Include junction and pull boxes to fulfill requirements pertaining to the limitations to the number of bends permitted in raceway between cable access points, the accessibility of cable joints and splices, and the application of cable supports.
4. Where the wires and cables following the same routing are indicated as running through separate pull boxes, it shall be understood that a segregation of the wires and cables is required. Separately indicated pull boxes may be incorporated into single boxes on condition that segregation is maintained by barriers of the type hereinafter specified.
5. Include all required junction and pull boxes regardless of indications on the drawings (which, due to symbolic methods of notation, may omit to show some of them).

#### B. Apply outlet boxes in accordance with the following:-

1. Unless noted below or otherwise specifically indicated, include a separate outlet box for each individual wiring device, lighting fixture and signal or communication system outlet component. Outlet boxes supplied attached to lighting fixtures shall not be used as replacements for the boxes specified herein unless they are specifically rated to accept "through circuit" building wires.
2. A continuous row of fixtures of the end-to-end channel type, designed for "through wiring," and wired in accordance with the specifications hereinafter pertaining to circuitry through a series of lighting fixtures, may be supplied through a single outlet box.
3. A series of separate fixtures, designed for "through wiring," spaced not more than 2 feet (600mm) apart, and interconnected with conduit or raceway and circuitry which is in accordance with the specifications hereinafter pertaining to circuitry through a series of lighting fixtures, may be supplied through a single outlet box.
4. Connection to recessed ceiling fixtures supplied with pigtails may be arranged so that more than one, but not more than four, such fixtures are connected into a single outlet box. When adopting this procedure:-
  - (a) Utilize an outlet box no smaller than 4-11/16 inches (119mm) square by 2-1/8 inches (54 mm) deep.

- (b) Allow no fixture to be supplied from an outlet box in another room.
5. Multiple local switches indicated at a single location shall be gang mounted in a single outlet box.
  6. Include all required outlet boxes regardless of indications on the drawings (which due to symbolic methods of notation, may omit to show some of them).
  7. Regardless of any indications on the drawings, flush wall mounted outlet boxes shall not be set back-to-back in fire rated walls or partitions, even if they are displaced vertically. Such outlets shall be offset horizontally by 24 inches (610mm) or as otherwise required to maintain the fire rating.
  8. Exclude "through-the-wall" collar type outlet boxes for flush devices indicated back-to-back in non-fire rated partitions or walls. Where necessary to accommodate box depths, outlets shown back-to-back shall be horizontally offset.
- C. Install junction boxes, pull boxes and outlet boxes in accordance with the following:-
1. Exclude surface mounted outlet boxes in conjunction with concealed circuitry.
  2. Exclude unused circuitry openings in junction and pull boxes. In larger boxes each such opening shall be closed with a galvanized sheet steel plate fastened with a continuous weld all around. In small outlet type boxes, utilize plugs as specified for such boxes.
  3. Close up all unused circuitry openings in outlet boxes. Unused openings in cast boxes shall be closed with approved cast metal threaded plugs. Unused openings in sheet metal boxes shall be closed with sheet metal knock-out plugs.
  4. Pack "through the wall" collar type outlet boxes with a sound deadening, non-hardening, non-hygroscopic, non- combustible, high dielectric stuffing material manufactured specifically for the purpose.
  5. Outlet boxes for switches shall be located at the strike side of doors. Indicated door swings are subject to field change. Outlet boxes shall be located on the basis of final door swing arrangements.
  6. Boxes and plaster covers for duplex receptacles shall be arranged for vertical mounting of the receptacle.
  7. Equip outlet boxes used for devices which are connected to wires of systems supplied by more than one set of voltage characteristics with barriers to separate the different systems.
- D. Barriers in junction and pull boxes of outlet size shall be of the same metal as the box.

- E. Barriers in junction and pull boxes which are larger than outlet size shall be of polyester resin fiberglass of adequate thickness for mechanical strength but in no case less than 1/4 inch (6.5mm). Each barrier shall be mounted, without fastenings, between angle iron guides so that they may be readily removed.

### 3.5 MOUNTING HEIGHTS

- A. Heights of all wall mounted outlets and equipment shall be in accordance with the following list. (Dimensions are above finished floor unless noted.)
  1. Receptacle or telephone outlet in field constructed wall, partition or column unless otherwise specified below -- 18 inches (45 cm) to centerline.
  2. Receptacle or telephone outlet in factory fabricated wall or partition, unless otherwise specified below -- Dimension determined by wall or partition construction.
  3. Receptacle or telephone outlet in mechanical spaces, electric switchboard rooms, electric closets -- 60 inches (150 cm) to centerline.
  4. Toggle switch outlet in field constructed wall partition or column -- 46 inches (117 cm) to centerline.
  5. Toggle switch outlet in factory fabricated wall or partition -- Dimension determined by wall or partition construction.
  6. Bracket lighting outlets, except for "over door" -- 90 inches (228 cm) to centerline.
  7. Bracket lighting outlet over door -- as required to center outlet between top surface of door lintel and underside of ceiling.
  8. Wall exit sign except for over door -- 90 inches (228 cm) to centerline.
  9. Exit sign over door -- As required to center sign between top surface of door lintel and underside of ceiling.
  10. Outlet for any signal system device other than fire alarm station requiring manual operation -- 46 inches (117 cm) to centerline.
  11. Manual fire alarm station -- 46 inches (117 cm) to centerline.
  12. Outlet for any signal system visual or sounding device other than fire alarm visual device or visual/sounding device -- As required for device to clear underside of ceiling by 1 inch (25 mm).
  13. Outlet for fire alarm visual device -- Visual device 80 inches (203 cm) AFF, except as otherwise noted.
  14. Clock outlet -- As required for clock to clear underside of ceiling by 1 inch (25 mm).

- B. Architectural drawings and field instructions issued by the Architect take precedence over the above list and shall be adhered to.

### 3.6 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at 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 touch-up coating recommended by the manufacturer.

### 3.7 CLEANING

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

END OF SECTION 16130



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**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. Floor service outlets, poke-through assemblies, and multioutlet assemblies.

**1.3 DEFINITIONS**

- A. GFCI: Ground-fault circuit interrupter.
- B. EMI: Electromagnetic interference.
- C. RFI: Radio-frequency interference.
- D. TVSS: Transient voltage surge suppressor.
- E. 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.

## 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, as amended by state and local codes.

## 1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Wiring Devices:
    - (a) Bryant Electric, Inc./Hubbell Subsidiary.
    - (b) Hubbell Incorporated; Wiring Device-Kellems.
    - (c) Leviton Mfg. Company Inc.
    - (d) Pass & Seymour/Legrand; Wiring Devices Div.
  - 2. Wiring Device type Lighting Dimmers:
    - (a) Lutron.
    - (b) Lightolier.
  - 3. 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.

4. Multioutlet Assemblies:
  - (a) Hubbell Incorporated; Wiring Device-Kellems.
  - (b) Wiremold Company (The).
5. 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. Receptacles: NEMA WD 6, Comply with NEMA WD 1, Federal Specification WC 596, and UL 498. Rectangular (decorator) style in public spaces.
- B. Straight-Blade and Locking Receptacles: Commercial specification grade, configuration 5-20R.
- C. GFCI Receptacles: Straight blade type, Commercial 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. Incorporate "through feed" features permitting the optional protection of downstream receptacles if desired.
- D. Isolated-Ground Receptacles: Straight blade, Commercial 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 varistors; 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.

2. Active TVSS Indication: Visual only with light visible in face of device to indicate device is "active" or "no longer in service."

## 2.3 SWITCHES

- A. Single- and Double-Pole Switches: Comply with NEMA WD 1 and WD 6, Federal Specification WS-896, and UL 20. Rectangular (decorator) style in public spaces.
  1. Snap Switches: Heavy-Duty grade, quiet type.
  2. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
    - (a) Control: Continuously adjustable; with single-pole or three-way switching to suit connections.
    - (b) 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. Suitable for use with magnetic or electronic low voltage lamp transformers as required to suit load.
    - (c) 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 20 percent of full brightness.

## 2.4 WALL PLATES

- A. Single and combination types with openings to match corresponding wiring devices. Comply with NEMA WD 1 and WD 6.
  1. Plate-Securing Screws: Metal with head color to match plate finish.
  2. Material for Finished Spaces: as indicated by architect
  3. Material for Unfinished Spaces: Galvanized steel Smooth.
  4. Material for Wet Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations." Enclosures for 120 Volt receptacles rated 20 Amperes or less are weatherproof whether or not the attachment plug cap is inserted.

## 2.5 FLOOR SERVICE FITTINGS

- A. Type: Modular **[flush-type] [flap-type] [above-floor]**, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.

- C. Service Plate: **[Rectangular] [Round], [die-cast aluminum] [solid brass]** with satin finish.
- D. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.

## 2.6 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
  - 2. Furniture feed type service assembly: connections for power and communications.
  - 3. Size: Selected to fit nominal cored holes in floor and matched to floor thickness.
  - 4. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
  - 5. Closure Plug: Arranged to close unused 3-inch (75-mm) 4-inch (100-mm) cored openings and reestablish fire rating of floor.
  - 6. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors; and a minimum of four, 4-pair, Category 5 voice and data communication cables.

## 2.7 MULTIOUTLET ASSEMBLIES

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

## 2.8 FINISHES

### A. Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect from manufacturer's standard colors, unless otherwise indicated or required by NFPA 70.
2. Wiring Devices Connected to Emergency Power System: Red.
3. Isolated-Ground Receptacles: Orange
4. Comply with NEMA WD 1.

## 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 devices under single, multigang wall plates.
- E. Remove wall plates and protect devices and assemblies during painting.
- F. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

### 3.2 IDENTIFICATION

- A. Comply with Division 16 Section "Electrical Identification."
1. Receptacles Connected to Emergency Power System: Identify panelboard and circuit number from which served. Use hot stamped or engraved machine printing with red-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

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**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. Photoelectric switches.
  - 3. Occupancy sensors.
  - 4. Multipole contactors.
- B. Related Sections include the following:
  - 1. Division 16 Section "Wiring Devices" for wall-box dimmers and manual light switches.
  - 2. Division 16 Section 16146 "Lighting Control Panelboards Powerlink G3".

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

**1.4 QUALITY ASSURANCE**

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



## 1.5 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. Lighting control devices have been specified on the drawings and in other Division 16 Sections. Where they 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.
    - a. Hubbell Building Automation
    - b. Lighting Control and Design
    - c. Square D PowerLink
    - d. Eaton/Cutler-Hammer
  - 2. All occupancy sensors shall be from same manufacturer.

### 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 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."

## 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 3/4 inch trade size (DN21).
- 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

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**SECTION 16190 - SUPPORTING DEVICES**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
- B. Related sections include the following:
  - 1. Refer to other Division 16 sections for additional specific support requirements that may be applicable to specific items.

**1.3 SUBMITTALS**

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of product specified.

**1.4 QUALITY ASSURANCE**

- A. Electrical Component Standard: Components and installation comply with NFPA 70, as amended by state and local codes.
- B. Electrical components are listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
  - 1. Slotted Metal Angle and U-Channel Systems:
    - (a) B-Line Systems, Inc.

- (b) Haydon Corp.
- (c) Kin-Line, Inc.
- (d) Unistrut Diversified Products

2. Conduit Sealing Bushings:

- (a) Cooper Industries, Inc.
- (b) L.E. Mason Co.
- (c) O-Z/Gedney
- (d) Raco, Inc.
- (e) Spring City Electrical Mfg. Co.
- (f) Thomas & Betts Corp.

## 2.2 COATINGS

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

## 2.3 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
  - 1. Fasteners: Types, materials, and construction features as follows:
  - 2. Expansion Anchors: Carbon steel wedge or sleeve type.
  - 3. Toggle Bolts: All steel springhead type.
- B. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

- E. U-Channel Systems: 16-gauge steel channels, with 9/16-inch (14 mm) diameter holes, at a minimum of 8 inches (20 cm) on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

## 2.4 FABRICATED SUPPORTING DEVICES

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide pipe sleeves of one of the following:
  - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge metal for sleeve diameter noted:
    - (a) 3 inch (8 cm) and smaller: 20-gauge.
    - (b) 4 inch (10 cm) to 6-inch (15 cm): 16-gauge.
    - (c) over 6-inch (15 cm): 14-gauge.
  - 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
  - 3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with Electrical Code requirements.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with NFPA 70, as amended by state and local codes, and the following requirements:
  - 1. Conform to manufacturer's recommendations for selection and installation of supports.
  - 2. Strength of each support is adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs (90 kg), provide additional strength until there is a minimum of 200 lbs (90 kg) safety allowance in the strength of each support.

3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
  4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
  5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch (DN 41) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4 inch (6 mm) diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
  6. Support exposed and concealed raceway within 1 foot (30 cm) of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
  7. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on conductor terminals.
- D. Vertical Conductor Supports: Install simultaneously with installation of conductors.
- E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches (60 cm) from the box.
- G. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations. For sleeves through fire-rated-wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with "Firestopping" requirement of Division 16 Section "Basic Electrical Materials and Methods."
- H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
  2. Holes cut to depth of more than 1-1/2 inches (4 cm) in reinforced concrete beams or to depth of more than 3/4 inch (2 cm) in concrete do not cut the main reinforcing bars. Fill holes that are not used.
  3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.
- J. In general, walls and partitions are not suitable for supporting the weight of panelboards, dry type transformers and the like. Include supporting frames or racks extending from floor slab to ceiling slab for all such items unless specifically instructed otherwise by the Architect.
- K. Include supporting frames or racks for equipment, intended for vertical surface mounting, which is required in a free standing position.
- L. Supporting frames or racks are of standard angle, standard channel or specialty support system steel members. They are rigidly bolted or welded together and adequately braced to form a substantial structure. Racks are of ample size to assure a workmanlike arrangement of all equipment mounted on them.
- M. No work intended for exposed installation in damp locations is mounted directly on any building surface. In such locations, flat bar members or spacers are used to create a minimum of 1/4 inch (6 mm) air space between the building surfaces and the work.
- N. Support vertical runs of bus duct at intervals no greater than the floor to floor height, or 13 feet (4 m), whichever is smaller. Support horizontal runs of bus duct at intervals no greater than 5 feet (150 cm).
- O. Nothing (including outlet, pull and junction boxes and fittings) depends on electric conduits, raceways or cables for support except that threaded hub type fittings having a gross volume not in excess of 100 cubic inches (1600 cc) may be supported from heavy wall conduit, where the conduit in turn is securely supported from the structure within 5 inches (12 cm) of the fitting on two opposite sides.
- P. Nothing rests on, or depends for support on, suspended ceiling media (tiles, lath, plaster, as well as splines, runners, bars and the like in the plane of the ceiling). Vertical members which suspend the ceiling (together with their horizontal bracing which occurs above the ceiling), however, may be used for support, subject to the following criteria:



1. Supporting procedures are in accordance with the ceiling system manufacturer's instructions.
  2. Supporting members for circuitry are rigid. Wires may not be used for such supports.
  3. The ceiling is not fire rated.
- Q. In conjunction with lighting fixtures or other items weighing less than 40 pounds (18 kg), the above restriction against supporting from suspended ceiling splines, runners or bars in the plane of the ceiling may be waived for ceilings which have been specifically approved for the weight and arrangement of fixtures being applied. Any support members, mechanical fastening means (i.e., bolts, screws or rivets), or other appurtenances, however, required to tie in or adapt to the fixtures and their ceiling opening frames (if any) to the ceiling in the approved manner are included as part of the electric work.
- R. As a minimum procedure, support surface or pendant mounted lighting fixture:-
1. From its outlet box by means of an interposed metal strap, where weight is less than 5 pounds (2 kg).
  2. From its outlet box by means of a hickey or other direct threaded connection, where weight is from 5 pounds (2 kg) to 50 pounds (20 kg).
  3. Directly from structural slab, deck or framing member, where weight exceeds 50 pounds (20 kg).
- S. As a minimum procedure, support recessed lighting fixtures as follows:
1. From ceiling suspension members, as described above, where weight is 80 pounds (35 kg) or less. Fluorescent fixtures are provided with clips to secure the fixtures to the ceiling members at two opposite ends of each fixture.
  2. Directly from structural slabs, decks or framing members where weight is more than 80 pounds (35 kg).
- T. Include in the electric work channel sills or skids for leveling and support of all floor mounted electrical equipment.
- U. Where permitted loading is exceeded by direct application of electrical equipment to a slab or deck, include in the electric work proper dunnage as required to distribute the weight in a safe manner.

END OF SECTION 16190

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**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 Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. This Section includes individually mounted enclosed switches and circuit breakers used for the following:
  - 1. Service disconnecting means.
  - 2. Feeder and branch-circuit protection.
  - 3. Motor and equipment disconnecting means.
- B. Related Sections include the following:
  - 1. Division 16 Section "Wiring Devices" for attachment plugs, receptacles, and toggle switches used for disconnecting means.
  - 2. Division 16 Section "Switchboards" for individually enclosed, fusible switches used as feeder protection.
  - 3. Division 16 Section "Fuses" for fusible devices.
  - 4. Division 16 Section "Selection of Overcurrent Devices" for additional information.
  - 5. Division 16 Section "Enclosed Controllers (Installation of)"
  - 6. Division 16 Section "Variable Frequency Controllers (Installation of)"

**1.3 SUBMITTALS**

- A. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each switch and circuit breaker include the following:
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.

2. Current and voltage ratings.
  3. Short-circuit current rating.
  4. UL listing for series rating of installed devices.
  5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- C. Field Test Reports: Written reports specified in Part 3.
- D. Maintenance Data: Include the following:
1. Routine maintenance requirements for components.
  2. Manufacturer's written instructions for testing and adjusting switches and circuit breakers.
  3. Time-current curves, including selectable ranges for each type of circuit breaker.

#### 1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by Underwriters Laboratories.
- B. Comply with NEMA AB 1 and NEMA KS 1.
- C. Comply with NFPA 70, as amended by state and local codes.

#### 1.5 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 (2000 m).

#### 1.6 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.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton Corp.; Cutler-Hammer Products
  2. General Electric Co.; Electrical Distribution & Control Division.
  3. Siemens Energy & Automation, Inc.
  4. Square D Co.

### 2.2 ENCLOSED SWITCHES

- A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle with provisions for two padlocks, and interlocked with cover in closed position. Where used as an in-sight disconnect interposed into the circuit between a Variable Frequency Controller (VFC) and a motor, or used as an in-sight disconnect for a hydraulic elevator, include an auxiliary contact to open the motor control circuit prior to opening of main contacts. Auxiliary contact shall close after the main contacts close. Where used as an in-sight disconnect where six conductors are required between the motor controller and the motor, switch shall be a six pole device regardless of indications on the drawings.
- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle with provisions for two padlocks, and interlocked with cover in closed position.
- C. Enclosed Fusible Switch, 1200A and Larger: Bolted pressure type, UL 977; operating mechanism shall utilize a rotary-mechanical bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.
- D. Service switches on 277/480 volt system shall have shunt trip mechanisms suitable for operation in response to manual activation, or automatic operation in response to ground fault relay.

### 2.3 ENCLOSED CIRCUIT BREAKERS

- A. Refer to Division 16 Section "Selection of Overcurrent Devices" for additional information.

### 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.

## 2.5 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosures before shipping.

## 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.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

### 3.3 IDENTIFICATION

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

### 3.4 CONNECTIONS

- A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.
- B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.
- C. Install control circuit lockout wiring between disconnect switches and VFC's.
- D. 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. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with

requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. 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.
- B. Testing 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.

### 3.6 ADJUSTING

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

### 3.7 CLEANING

- A. On completion of installation, inspect interior and exterior of enclosures. 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 16410

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**SECTION 16420 - ENCLOSED CONTROLLERS  
(INSTALLATION OF)**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes the installation of A.C. individually enclosed motor controllers rated 600 V and below. The motor controllers will be furnished as part of Division 15 and Division 13.
- B. Related Sections include the following:
  - 1. Division 16 Section "Basic Electrical Materials and Methods" for general materials and installation methods.
  - 2. Division 16 Section "Selection of Overcurrent Devices" for OCD's and disconnect switches used with motor controllers.
  - 3. Division 15 Section "Enclosed Controllers (Installation of)".
  - 4. Division 16 Section "Variable Frequency Controllers, Installation of"

**1.3 SUBMITTALS**

- A. Field Test Reports: Written reports specified in Part 3.

**1.4 QUALITY ASSURANCE**

- A. Comply with NFPA 70, as amended by state and local codes.
- B. The terms "listed" and "labeled" are defined as they are in the National Electrical Code, Article 100.

**1.5 COORDINATION**

- A. Coordinate layout and installation of enclosed controllers 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 features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

- C. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

## PART 2 - PRODUCTS

(NOT APPLICABLE)

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General: Install independently mounted motor control devices in accordance with manufacturer's written instructions.
- B. Location: Locate controllers as indicated and within sight of motors controlled. Where controller is not located within sight of the motor controlled (as defined in the National Electrical Code), provide a nonfusible disconnect switch to serve as the local motor disconnect.
- C. Mounting: For control equipment at walls, bolt units to wall or mount on light-weight structural steel channels bolted to the wall. For controllers not at walls, provide freestanding racks fabricated of structural steel members and light-weight slotted structural steel channels.
- D. Motor-Controller Fuses: Install fuses in each fusible switch. Conform to requirements of Division 16 Section "Overcurrent Protection Device Coordination."
- E. Modify as required the internal control of motors if necessary to accommodate connection of external control wiring in accordance with applicable wiring diagrams.
- F. Relay settings: Modify factory settings of adjustable time delay relays in accordance with an approved schedule.

### 3.2 IDENTIFICATION

- A. Identify motor control components and control wiring in accordance with Division 16 Section "Electrical Identification." Where not cover mounted on motor controller, device identification nameplate identify the associated motors.

### 3.3 CONTROL WIRING

- A. Control wiring for HVAC motors will be provided as part of the Building Management System (central mechanical control system) work of Division 15, except for the following wiring which is provided as part of the electrical work (Division 16):



1. For each motor automatically and/or manually controlled or monitored by the fire alarm system, include control wiring extensions as specified as part of the fire alarm system to an adjacent FPA addressable modules.
  2. For each motor supplied by a VFC, run 2 #14 from the disconnect switch at the motor to the VFC, and connect so as to de-energize "start circuit" when switch is open. Run with power circuitry or in separate raceway.
- B. Control wiring for plumbing/fire protection motors is provided as part of the electrical work. For each such motor, provide wiring and connect to all outlying control devices as directed. Refer to plumbing and fire protection drawings and specifications for quantities and locations.
  - C. Damper Control Interface: Start command to open associated dampers before the motor is allowed to operate. Input to accept damper limit switch contact closure to allow the motor to operate in hand and auto or remote mode.
  - D. Safety Control Interface: Input to accept safety device contact closure to stop motor operation in hand and auto or remote mode.
  - E. Control wiring is accomplished utilizing #14 AWG copper conductor with THWN insulation run in conduit as specified for feeders in Division 16, Section "Raceways."
  - F. Include any necessary field installed make-up wiring (within motor controller enclosures) as required to incorporate the contained devices and accessories into the control scheme.

### 3.4 MOTOR CONTROLLER FUSES

- A. Motor-Controller Fuses: Install indicated fuses in each fusible switch.

### 3.5 CONTROL WIRING INSTALLATION

- A. Install required control wiring according to Division 16 Section "Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switches and other automatic control devices and accessories within controllers as required to accommodate the control scheme.
  1. Connect selector switches to bypass only the manual and automatic control devices that have no safety functions when switch is in the hand position.
  2. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### 3.6 CONNECTIONS

- A. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Ground equipment.

### 3.7 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
  - 1. Test insulation resistance for each enclosed controller bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- B. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
  - 1. Procedures: Perform each electrical test and visual and mechanical inspection indicated in NETA ATS, Sections 7.5, 7.6, and 7.16. 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.
- C. Testing 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.

### 3.8 ADJUSTING

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

### 3.9 CLEANING

- A. Clean enclosed controllers internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 16420

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**SECTION 16422 - SELECTION OF OVERCURRENT  
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 all overcurrent protective devices (OCPD's) (OCD's) required for the project. It defines the type of OCPD required for each individually mounted device, panelboard, switchboard, switchgear and miscellaneous device required.
- B. Related Sections: The following Sections requirements relate to this Section:
  - 1. Division 16, Section "Enclosed Switches and Circuit Breakers."
  - 2. Division 16, Section "Panelboards."
  - 3. Division 16, Section "Switchboards."
  - 4. Division 16, Section "Switchgear."

**1.3 SUBMITTALS**

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specifications Section.
- B. Descriptive data defining how the required short circuit ratings will be met by the equipment furnished under the Related Sections described above. System shall be fully rated.
- C. In advance of, or in conjunction with, the submission of shop drawings for approval, provide data defining in detail how the required coordination and short circuit current ratings specified elsewhere in these specifications are achieved with the equipment being furnished under the listed Related Sections. The data shall, in narrative or graphic fashion, fully define how the various devices, individually, or in combination, comply with the "fully rated" short circuit current requirements. Include certifications from the manufacturer as to the UL approvals for these ratings for all proposed equipment. Short circuit and coordination study shall include recommended device settings. In particular, demonstrate selective coordination of overcurrent devices used for Emergency Systems and Legally Required Standby Systems.
- D. Arc flash study indicating arc flash hazard at each piece of distribution equipment.

## 1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70 as amended by state and local codes.
- B. Listing and Labeling: Products - as described with the Related Sections above - shall be Underwriters Laboratories listed and labeled as defined in NFPA 70 Article 100.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Refer to Related Sections listed hereinbefore for general product requirements.
- B. Short circuit current ratings, and the manufacturer's labels attesting to these ratings (based on U.L. listings), will be required for overcurrent protection devices, where they are individually mounted and for the equipment assemblies when they are incorporated in panels, switchboards, switchgear, etc. Such ratings shall be in accordance with the following:-
  - 1. In order to insure that they are at least equal to the available fault current, minimum ratings have been specified herein for the individual overcurrent device types, and in the pertinent sections for panelboards, switchboards, switchgear and other assemblies or devices. .
- C. All overcurrent protection and switching devices shall be U.L. listed as suitable for the termination of 75 degree C conductors, sized in accordance with their 75 degree C ampacity ratings. Devices shall be specifically identified accordingly and shall bear the designation "60 / 75 degree C" or "75 degree C", regardless of whether incorporated in panelboards, switchboards or other assemblies or whether individually mounted.

### 2.2 APPLICATION

- A. Overcurrent protective devices (OCD'S) shall be provided as described hereinafter.
- B. OCD's shall be of the current limiting circuit breaker type (CLCB) except as noted hereinafter.
- C. Branch circuit breakers in 277/480 (265/460) volt lighting or appliance panels shall be of the standard molded case type.
- D. Main and branch circuit breakers in 120/208 volt panelboards of all types shall be of the standard molded case type.
- E. Individually mounted overcurrent protection and switching devices shall be as follows:
  - 1. For use on 277/480 (265/460) volt circuits, they shall be of the CLCB molded case breaker type.

2. For use on 120/208 volt circuits, they shall be of the standard molded case circuit breaker type.
- F. Emergency Systems and Legally Required Standby Systems: Overcurrent devices shall be selected such that all overcurrent devices in the distribution system are selectively coordinated.
1. Overcurrent devices for Emergency Systems and Legally Required Standby Systems shall be switch and fuse type. Devices up to and including 800 amperes shall be quick-make, quick-break type switches with cartridge fuses. Devices over 800 amperes shall be bolted pressure type switches with cartridge fuses. This requirement includes all overcurrent devices providing utility service to the transfer switches, providing generator power to the transfer switches, and on the load side of transfer switches - including branch circuit overcurrent protection.
  2. Short circuit rating of panelboards and devices shall be as required to provide a fully rated system.

## 2.3 CURRENT LIMITING CIRCUIT BREAKERS

- A. Where intended for mounting in main switchboards, switchgear or as individually mounted service switches they shall be of the 100 percent rated (i.e., capable of carrying 100 percent of their rating continuously), fixed (stationary) mounted and drawout mounted air frame type, with current limiting fuses accessibly mounted in the line side bus connections to each pole of the breakers. They shall be as follows:
1. Their circuit breaker elements shall consist of quick-make quick-break mechanically trip free air immersed circuit breaker mechanisms arranged to operate all poles simultaneously and equipped with an adjustable solid state type overcurrent tripping device, incorporating:-
    - (a) Short time inverse current characteristic tripping in main breakers.
    - (b) Instantaneous short circuit tripping except in main breakers.
    - (c) Long time inverse current characteristic tripping for all breakers.
    - (d) Ground fault tripping. Refer to Division 16 Section entitled "Main Switchboards "Switchgear" for further information regarding features and functions. Dry contacts which close on ground fault trip shall be provided for monitoring by the BMS.
  2. Their breaker contacts shall be complete with arc quenchers in each pole, interpole barriers and latches with mechanical pushbutton trips and position indicators.
  3. They shall have shunt trip devices complete with control transformers, "line side" shunt trip control supply connections, and internal factory wiring to accessible terminals as required for the present or future extension of the trip control circuit at a 120 volt control voltage level, to remote normally open external actuating devices.

4. They shall have phase failure protection relay systems arranged to trip them open in response to a sustained voltage in any phase which is lower than 75 percent of the other phase voltages.
  5. Sizing of the current limiting fuse for each circuit shall be as selected by the manufacturer as part of the coordination study. Fuses shall be capable of safely interrupting currents of up to 200,000 amperes RMS symmetrical. Fuses shall coordinate with, and back up, the associated circuit breakers so that faults up to the safe capability of the breakers will be interrupted by the breakers, and larger faults will be interrupted by the fuse without damage to the breakers.
- B. Current limiting circuit breakers intended for use in power and/or distribution panels, or for use as individually mounted overcurrent protection devices, shall be of the molded case type. In ratings up to the maximum frame size in which they are available from the manufacturer, they shall be of the fuseless type. In larger frame sizes, they shall be of a type which incorporates an integral current limiting fuse in each pole. Current limiting molded case circuit breakers shall be as follows:
1. Their breaker elements shall consist of manually operated, quick-make, quick-break, mechanically trip free operating mechanisms for simultaneous operation of all poles, with contacts, arc interrupters and trip elements for each pole.
  2. Their breaker tripping units shall be of the adjustable solid state type incorporating long time delay and instantaneous tripping, or of the "thermal-magnetic" type having bi-metallic elements for time delay overload protection, and magnetic elements for short circuit protection.
  3. They shall be of either the fuseless type or of the type which incorporates current limiting fuses.
  4. Where of the fuseless type, they shall incorporate high speed blow-apart current limiting contacts, and shall have a short circuit interrupting capacity of at least 150,000 RMS symmetrical amperes at the specified system voltage.
  5. Where they are of the type which incorporates fuses (i.e., in frame sizes larger than 400 amps), they shall be as follows:-
    - (a) Their fuses shall be equipped with release buttons arranged to trip open the latches of their circuit breaker elements.
    - (b) Each shall have its fuses and breaker elements integrally mounted in a single overall molded phenolic plastic case.

- (c) The fuses shall be capable of safely interrupting fault currents in the order of 200,000 amperes RMS symmetrical. The current limiting fuses shall coordinate with and back up the circuit breakers they are associated with so that all fault overload currents occurring within the safe capability of the breakers shall cause the breakers to open, and all currents occurring beyond the safe capability of the breakers shall cause the fuses to open; the opening of fuses being such as to prevent damage to any circuit breaker components parts.
- C. In lieu of the air frame CLCB's specified hereinbefore for mounting in main switchboards or as individually mounted service switches, stationery molded case circuit breaker sizes may be utilized in frame sizes up to 800 amps. They shall be as follows:
  - 1. They shall be 100 percent rated.
  - 2. They shall be provided with solid state tripping devices, incorporating all of the features and characteristics specified hereinbefore for current limiting air frame circuit breakers.
  - 3. They shall in all other respects comply with the requirements specified for current limiting circuit breakers in power and/or distribution panels.

## 2.4 STANDARD MOLDED CASE CIRCUIT BREAKERS

- A. Standard molded case circuit breakers shall comply with the following:-
  - 1. They shall consist of manually operated quick-make, quick-break mechanically trip free operating mechanisms for simultaneous operation of all poles, with contacts, arc interrupters and trip elements for each pole, all enclosed in molded phenolic plastic cases.
  - 2. Their tripping units shall be of the "thermal magnetic" type having bi-metallic elements for time delay overload protection, and magnetic elements for short circuit protection.
  - 3. Where no frame sizes are indicated their interrupting capacity (in RMS symmetrical amperes) shall not be less than 14,000 amperes for use in 277/480 (265/460) volt lighting and appliance panels, nor less than 10,000 amperes for use in 120/208 volt lighting or appliance panels.
  - 4. Where frame sizes are indicated their interrupting capacity (in RMS symmetrical amperes) shall not be less than 22,000 amperes for 100 amperes and 225 amperes frame circuit breakers, nor less than 42,000 amperes for larger frame sizes.
  - 5. The minimum interrupting capacity in symmetrical RMS amperes of the circuit breakers intended for use in panelboards shall be as noted above.
  - 6. They shall be of the "bolted-in" type.
  - 7. Single pole breakers sized 20 amps or less shall be rated for switching duty.

8. Where utilized for circuits supplying HID lighting, they shall be HID rated.
9. They shall be multi-pole circuit breakers, or single-pole circuit breakers with handle ties where serving multi-wire branch circuits in relocatable partitions or systems furniture.
10. They shall be equipped with 5 milliamp sensitivity ground fault interrupting features where so indicated, and/or where they supply 120 volt, 15- and 20-ampere receptacles in bathrooms, kitchens, within 6 feet of sinks, where intended for use by vending machines, and other such code mandated locations and with 30 milliamps sensitivity G.F.I. features where they supply piping tracing cables or snow melting cables or gutter de-icing cables or HWAT cables.

## 2.5 BOLTED PRESSURE SWITCHES

### A. Select bolted pressure type distribution switches in accordance with the following:-

1. They shall have copper current-carrying elements having silver plated contact surfaces.
2. They shall have blade locks to prevent them from opening under short circuit stresses and a mechanism which produces initial contact pressure on the jaws in addition to final bolted pressure when they are closed.
3. They shall be capable of interrupting at least 12 time their rating without damage in accordance with NEMA and UL performance standards.
4. They shall have auxiliary renewable arcing contacts which "make" before and "break" after main current-carrying elements function.
5. They shall be equipped with operating mechanisms which incorporate manual closing and tripping.
6. Where used as service disconnects, they incorporate electrical tripping. Electrical tripping shall incorporate a stored energy mechanism that permits closure only after the opening mechanism has been charged. They shall be complete with control transformers, "line side" trip control supply connections, and internal factory wiring to accessible terminals as required for the present or future extension of the trip control circuit at a 120 volt control voltage level, to remote normally open external actuating devices. The trip circuit shall operate down to 55 percent of nominal voltage.
7. They shall be designed for use with Class "L" fuses.
8. They shall be 100 percent rated when mounted in an enclosure, in accordance with UL test procedures for individual mounting or for incorporation into panelboards or switchboards.
9. They shall be equipped with an Open-Fuse Trip Device arranged to trip switch open if a phase fuse opens.



## 2.6 QUICK-MAKE, QUICK-BREAK SWITCHES

- A. Select quick-make, quick-break type distribution switches in accordance with the following:-
1. They shall equal or exceed the performance required for NEMA type H.D. horsepower rated switches.
  2. They shall have arc quenchers and circuit breaker type pressure contacts.
  3. Where intended for panelboard or switchboard mounting, they shall be of the "bolted-in" type.
  4. They shall be designed for use only with Class "J" fuses up to 600 amps, and "Class L" fuses above 600 amps. Where protecting a branch circuit for emergency systems and legally required standby systems, fuses shall be current limiting type. They shall incorporate factory installed clips designed to insure the use of proper fuses. Coordinate to insure that fuses supplied for the project match these fuse gaps.
  5. Switches 400 amperes or larger shall be equipped with an Open-Fuse Trip Device arranged to trip switch open if a phase fuse opens.

## 2.7 FUSES

- A. Select fuses for use in switch and fuse type overcurrent devices in accordance with the following:
1. Regardless of the actual available fault current they shall, at full recovery voltage, be capable of safely interrupting fault currents of 200,000 amperes RMS symmetrical deliverable at the line side of the fuse.
  2. They shall be suitable for application to fuse gaps which reject other types of fusing. Coordinate with supplier(s) of all fusible switch units (in panels, switchboards, etc.) for the project to insure that fuse gaps match the specified fuse types.
  3. Except as noted hereinafter, in sizes up to 600 amps, they shall be of the Class "J" time delay type, capable of carrying 500 percent of rated current for not less than 10 seconds and UL listed as a "Class J" fuse. Fuses shall be Shawmutt Type "AJT", Bussmann Type "LPJ", or other approved. Approval is contingent on certified test data demonstrating full compliance with the following requirements:-
    - (a) Fuse shall carry 500 percent of rating for at least 10 seconds.

- (b) Fuse shall be suitable for motor feeders when applied at 150 percent of motor full load current.
- (c) Fuse selectivity with downstream fuses shall be:-
  - (1) 2:1 with "J" time delay
  - (2) 3:1 with "RK-5" time delay
  - (3) 2:1 with "RK-1" time delay
- 4. Where intended for use in motor starters (individual, or in motor control centers) they shall be of the dual element time delay type, UL listed as "Class RK-5", and capable of carrying 500 percent of rating for at least 10 seconds. Utilize "Class RK-1" time delay fuses where required to insure coordination with upstream fuses.
- 5. Where protecting a branch circuit fuses shall be current limiting type.
- 6. Except as noted hereinafter, in sizes over 600 amps, they shall be of the current limiting type, UL listed as "Class L".
- 7. Where protecting a feeder or tap supplying a single large motor or transformer, fuses in the range of 800 to 2000 amps shall have special "Class L" time delay characteristics equal to Shawmutt Type "A4BT" or Bussmann Type "KRP-C" fuses.

## 2.8 GROUND FAULT TRIPPING

- A. Provide ground fault tripping for each individually mounted service switch over 800 amps and for each main switchboard device and each switchgear device.

## 2.9 ELEVATOR POWER/DISTRIBUTION PANELS

- A. Branch units in power/distribution panels supplying elevators shall be of the quick-make, quick-break distribution switch type with time delay fuses.
  - 1. Where serving as the in-sight disconnect for a hydraulic elevator, they shall incorporate an auxiliary dry contact.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Comply with the requirements of Division 16 Sections "Enclosed Switches and Circuit Breakers," "Fuses," "Panelboards," "Switchboards" and "Switchgear".

- B. Submit recommended settings for all adjustable or interchangeable overcurrent and ground fault tripping devices. Include a complete short circuit and coordination study to demonstrate that the recommended device settings will provide a completely coordinated system based on the available fault currents. Full coordination of all devices used for Emergency Systems and Legally Required Standby Systems is required. Include all work required in the field to verify that factory settings are as recommended, and to field set device whose settings are not as recommended.

END OF SECTION 16422

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**SECTION 16424 - FEEDERS AND BRANCH  
CIRCUITRY**

**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 basic requirements for the installation of light and power feeders and circuitry run at less than 600 volts.
- B. Related Sections: The following sections contain requirements that relate to this Section:
  - 1. Division 16, Section "Raceways and Boxes."
  - 2. Division 16, Section "Conductors and Cables."
  - 3. Division 16, Section "Panelboards."

**1.3 SUBMITTALS**

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Circuited up "as-built" drawings and panel directories as called for in the Division 16 related sections.

**1.4 QUALITY ASSURANCE**

- A. Comply with NFPA 70, as amended by state and local codes.

**PART 2 - PRODUCTS**

**2.1 GENERAL**

- A. Products shall be as specified in the Division 16 related sections.

**PART 3 - EXECUTION**

**3.1 INSTALLATION OF FEEDERS**

- A. Feeder connections shall be in the phase rotation which establishes proper operation for all equipment supplied.

- B. Feeders consisting of multiple cables and raceways shall be arranged such that each raceway of the feeder contains one cable for each phase leg (and one neutral cable if any).
- C. Each individual tap off a feeder which consists of multiple cables per phase (and neutral if any) shall be arranged so that all of the cables of a phase leg (and neutral if any) of the feeder are connected to the corresponding phase leg (and neutral if any) of the individual tap.
- D. Indications of conductor sizing for three phase and three phase/four wire feeders shall, unless otherwise noted on the drawings, be understood as follows:
  - 1. (3) equally sized conductors represents a three phase feeder.
  - 2. (4) equally sized conductors represents a three phase/4 wire feeder with 100% neutral.
  - 3. (3) equally sized conductors plus (1) smaller conductor represents a three phase/three wire feeder plus ground wire.
  - 4. (4) equally sized conductors plus (1) smaller conductor represents a three phase/four wire feeder plus ground wire).
  - 5. (3) equally sized conductors plus (1) larger conductor or (2) equally sized conductors represents a three phase/4 wire feeder with neutral oversized to accommodate "harmonic-rich loads."
  - 6. (3) equally sized conductors plus (1) larger conductor or (2) equally sized conductors and one smaller conductor represents a three phase/four wire feeder with neutral oversized to accommodate "harmonic-rich" loads plus a ground wire.

### 3.2 INSTALLATION OF LIGHTING AND APPLIANCE BRANCH CIRCUITRY

- A. Circuitry indicated without sizing shall be understood to be lighting and appliance branch circuitry protected at 20 amps or less.
- B. Conform all lighting and appliance branch circuitry (regardless of whether protected above or below 20 amps) to the following:-
  - 1. Except as noted below, circuitry shall be multi-wire utilizing common neutrals arranged so that no neutral conductor acts as a common wire for more than one circuit conductor connected to the same phase leg of the supply system.
    - (a) Common neutrals shall not be utilized for circuitry runs emanating from panel branches having ground fault interrupting features regardless of any indication to the contrary on the floor plans.
    - (b) Common neutrals shall not be utilized for circuitry runs containing more than (6) 120 volt receptacle circuits within a single raceway (conduit, underfloor duct).

2. Conductors used as common neutrals for multiple (2 or 3) 120 volt branch circuits protected at 20 amps or less shall be #10 AWG where such circuits supply receptacles which are dedicated to - or may be utilized for - "harmonic-rich" loads such as personal computers, computer terminals, word processors, printers and the like. Accordingly, common neutrals supplying receptacles shall be understood to be #10 AWG under the following conditions:
    - (a) Wherever so indicated (by note or otherwise) on the drawings.
    - (b) Throughout all office areas, computer rooms or other data processing spaces and laboratories.
  3. Branch circuitry supplying relay controlled lighting fixtures shall be understood to include all necessary interconnections between the control panels containing the relays and the associated lighting or appliance panels.
  4. Under no condition shall any local switch break a neutral conductor.
  5. At any location where lighting and appliance branch circuitry is extended from a flush mounted panelboard to a suspended ceiling immediately above, at least four 1-inch empty conduits shall be included (in addition to those required for active circuitry) to permit future wiring escape from the panelboard. The empty conduits shall extend up from the panel and shall terminate in a threaded conduit cap immediately after turning out into the hung ceiling space.
  6. Raceway sizes shall conform to standard maximum permissible occupancy requirements except where these are exceeded by other requirements specified elsewhere.
  7. Two and three pole branches in panels shall be used respectively for individual single phase load items connected line to line and individual three phase load items. Where circuitry indications require the use of 2-pole and/or 3-pole branch breakers which have not been scheduled, provide in the panelboards the required multi-pole breakers in lieu of the equivalent number of single pole branch breakers. Required quantities of single, two and three pole branch breakers shall be confirmed prior to ordering panels.
- C. Conform lighting and appliance branch circuitry, indicated as being protected at 20 amps or less, to the following:-
1. 120 volt circuitry shall be supplied from 20 amp panel branches except as indicated otherwise.
  2. 277 (265) volt circuitry shall be supplied from 20 amp panel branches except as indicated otherwise.
  3. Except as specified below, minimum conductor size shall be #12 AWG.

4. Common neutrals shall not be utilized for circuitry runs containing more than (6) 120 volt receptacle circuits within a single raceway (conduit, cellular deck, underfloor duct]) except as noted below.
5. For circuitry run in underfloor raceway systems (cellular deck, underfloor duct), comply with the following:
  - (a) Utilize #10 AWG phase leg conductors and #8 AWG neutral conductors for runs contained in branch cells or ducts (i.e., cells or ducts intended for the direct supplying of receptacles or other outlets from after-set inserts or pre-set inserts mounted on them).
  - (b) Utilize #8 AWG conductors for home run circuitry contained in main runs (i.e., trench headers, junction headers or header ducts).
  - (c) Common neutrals shall be utilized for all circuitry contained in main runs and branch runs. Neutral conductors shall be tapped and reduced in insert outlet boxes to #10 or #12 AWG for direct connection to receptacles.
6. Conductors for 120 volt circuitry extending in excess of 75 feet, from the point of supply, to the first outlet shall be #10 AWG (minimum) copper to the first outlet. Increase beyond #10 AWG if required for compliance with code-mandated voltage drop restrictions.
7. Conductors for 277 (265) volt circuitry extending in excess of 150 feet, from the point of supply, to the first outlet shall be #10 AWG (minimum) copper to the first outlet. Increase beyond #10 AWG if required for compliance with code-mandated voltage drop restrictions.
8. Conductors used in runs consisting of more than six wires (exclusive of grounding conductors) in a single raceway shall be #10 AWG copper minimum. Increase beyond #10 AWG as required to comply with code-mandated derating factors, and as specified hereinbefore.
9. Circuits supplying receptacles which are not of the ground fault circuit interrupting type, and are located as noted below, shall be connected to panel branches that are equipped with ground fault interrupting features:
  - (a) Receptacles located in bathrooms. Bathrooms shall be defined as spaces containing a basin plus a toilet, tub or shower.
  - (b) Receptacles located within 6 feet of any sink and intended to serve counter top surfaces.
  - (c) Receptacles in commercial and institutional kitchens.
  - (d) All receptacles mounted on building exterior surfaces.
  - (e) All receptacles mounted in garages.
  - (f) All receptacles mounted in elevator machine rooms, machinery spaces and pits.

10. Circuits supplying pipe tracing cable, snow melting cable, gutter melting cable and HWAT cable shall be connected to panel branches equipped with 30 ma interrupting features for equipment protection.

D. Where circuitry has not been delineated for lighting fixtures, receptacles, switches and miscellaneous items intended for protection at 20 amps, such items shall be provided with circuitry conforming to the requirements listed below. Prior to installation of circuitry, submit for review floor plans showing circuit numbers, home runs, and interconnecting circuitry for all such items.

1. When circuiting up recessed ceiling lighting fixtures, connect fixtures on the basis of more than one fixture to a single outlet box, in an approved manner, as required to insure that circuits will not be unnecessarily lightly loaded due to mandated, restrictions on the maximum number of outlets per circuit. Except with special permission, unnecessarily light loading shall be understood to mean, less than 1000 volt amps (VA) on a 120 volt circuit and less than 3200 VA on a 277 volt circuit.
2. The total load on a circuit shall be computed by ascribing volt-amps to individual items on the basis of the following:-

<u>ITEM</u>	<u>VOLT-AMPS (VA)</u>
Any lighting fixture.	Input volt-amps as per lighting fixture schedule.
Any outlet with no specific wattage or circuiting instruction indicated.	180 volt amperes
Any outlet (other than for resistance heating) with wattage indicated.	1.15 x Indicated wattage
Any resistance heating outlet with wattage indicated.	1.0 x Indicated wattage
Any fractional HP motor with HP indicated.	2500 x Indicated HP
Any outlet with amps indicated.	120 x Indicated amps

3. Not more than 1300 total VA shall be applied to any 15 amp, 120 volt panel branch circuit nor more than 1450 VA to any 20 amp, 120 volt branch circuit. Not more than 4000 VA shall be applied to any 277 (265) panel branch circuit.
4. A separate 20 amp panel branch circuit supplying no other outlets shall be used for each outlet indicated as an "individual appliance circuit" or "heavy duty" outlet.



5. Lighting fixture shall be connected to 20 amp panel branch circuits. Solidly connected equipment less than 1300 VA shall be connected to 15 amp panel branch circuits except as indicated or noted herein.
6. Lighting fixtures and receptacles shall not be connected to the same branch circuit.
7. Any installed lighting and appliance branch circuitry, found (as a result of unnecessarily light loading of conductors) to make excessive use of panel branches, shall be rearranged.
8. Circuits shall be balanced on phases at their supply point as evenly as possible.
9. The final arrangement of lighting and appliance branch circuitry shall be fully delineated on the record, or "as-built" drawings called for elsewhere.

END OF SECTION 16424

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**SECTION 16442 - PANELBOARDS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of 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. Lighting and appliance branch circuit panelboards.
  - 2. Power and distribution panelboards.
- B. Related Sections include the following:
  - 1. Division 16 "Selection of Overcurrent Devices" for overcurrent protection program.
  - 2. Division 16 Section "Fuses".
  - 3. Division 16 Section "Transient Voltage Suppression" for surge protection.
  - 4. Division 16 Section "Lighting Control Panelboards Powerlink G3".

**1.3 DEFINITIONS**

- A. Overcurrent Protective Device (OCD) (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

**1.4 SUBMITTALS**

- A. Product Data: For each type of panelboard, 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.
  - 1. 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) UL listing for series rating of installed devices where applicable.
  - (e) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- C. Field Test Reports: Submit written test reports and include 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.
- D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- E. Operation and Maintenance Data: For panelboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Operation and Maintenance Data," 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, OCD's, components and accessories through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by Underwriters Laboratories Inc.
- C. Comply with NEMA PB 1.
- D. Comply with UL 50, 87, 486A, 869 and NEMA 250, AB1 and KS1.
- E. Comply with NFPA 70 as amended by state and local codes.

## 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
  - 1. Ambient Temperature: Not exceeding 104 degrees F (40 degrees C).
  - 2. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Condition: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperature within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

## 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.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

1. Panelboards and Accessories:
  - (a) Eaton Corp.; Cutler-Hammer Products.
  - (b) General Electric Co.; Electrical Distribution & Control Div.
  - (c) Siemens Energy & Automation, Inc.
  - (d) Square D Co.

### 2.2 MANUFACTURED UNITS

- A. Factory tests: Dielectric test, phase to phase and phase to ground, at twice the rated voltage plus 1,000 volts (1,500 volts minimum) for one minute. Date of test and the name and title of the individual certifying the test shall be indicated on a label affixed to the equipment.
- B. Enclosures: Flush- and surface mounted cabinets. NEMA PB 1, Type 1, to meet environmental conditions at 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.
- C. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- D. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

- E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.
- F. Bus: Hard-drawn copper, 98 percent conductivity
- G. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
- H. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
- I. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
- J. Main and Neutral Lugs: Type suitable for use with conductor material.
- K. Feed-through Lugs: Type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
- L. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- M. Where wires or cables are used within panelboards to make up internal connections (factory installed or otherwise) such wire or cable shall have copper conductors only.
- N. Where indicated or as required to assure ready accessibility of top switching and overcurrent device, they shall be arranged as multiple adjacent sections. A single overall cabinet shall be supplied for the multiple adjacent sections which constitute one panel. 1/4 inch (7 mm) minimum thickness plastic barriers having adequate angle iron framing support all around shall be included between sections. The entire assembly shall be such as to include wiring gutter space for each section as if it were an individual panelboard. Common bussing shall be arranged for adjacent sections unless there is indication that the individual sections are to be separately supplied. Sub-feed lugs with full capacity cable taps to adjacent panel sections will be accepted as the bussing method.

## 2.3 POWER OR DISTRIBUTION PANELBOARDS

- A. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.
- B. Main Overcurrent Protective Devices and Branch Overcurrent Protective Devices: as specified in Division 16, Section "Selection of Overcurrent Devices."
- C. Cabinet: width and a depth adequate for a three pole branch device equal in rating to the panel mains. In no case shall the cabinet be wider than 42 inches (106 cm) or deeper than 18 inches (46 cm).

## 2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- 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.
- C. Gutter space: adequate space for connecting to all active and spare branches.
- D. Cabinet width: not to exceed 24 inches (61 cm).
- E. Cabinet depth: not to exceed 6 inches (15 cm).

## 2.5 PANELBOARD BUSES

- A. The neutral buses of 120/208 volt panels supplying "harmonic-rich" line-to-neutral loads shall have ampacities larger than those of the phase legs in such panels in accordance with the following criteria:
  - 1. In no case shall the neutral bus ampacity of any panel supplied by a feeder with a neutral conductor which is larger than the phase conductors be less than the lesser of:
    - (a) The ampacity of the neutral conductor of the feeder supplying the panel.
    - (b) Twice the ampacity of the upstream overcurrent device protecting the feeder supplying the panel.
  - 2. The above requirements for the sizing of panel neutral buses shall override any indications on the drawings that smaller neutral buses are acceptable.
  - 3. Neutral buses shall be equipped with lugs capable of accepting single conductors (i.e., not paralleled) of an ampacity equal to the neutral bus rating (except where the neutral bus rating exceeds 400 amps).
  - 4. If required by manufacturer in order to comply with increased neutral bus sizing criteria specified above, increase phase leg bussing, as well.
  - 5. Refer to the light and power riser diagram or to other electrical drawings to determine which panels - if any - are supplied by feeders having "over-sized neutrals" and therefore require up-sizing of the panel neutral bus.
- B. A ground bus shall be provided for each panel. The ground bus shall be insulated from the panelboard cabinet.

## 2.6 OVERCURRENT PROTECTIVE DEVICES

- A. As described in Division 16 Section "Selection of Overcurrent Devices".

## 2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items as required for overcurrent protective device test, inspection, maintenance, and operation.

- B. Switch and fuse units incorporated as part of panelboards shall be equipped with factory installed rejection clips to restrict fuses to types specified in Division 16, Section "Selection of Overcurrent Devices." Modify or replace in field any incorrect fuse clips.
- C. Provide "lock-on" clips for the toggle handles of 5 percent of the branches in all lighting and appliance panels. Apply these clips to circuits supplying clocks, fan coil units and others as directed in the field.
- D. Furnish handle padlock attachments for 5 percent of the branches in lighting and appliance panels, and padlocks (with key) for 10 percent of these padlock attachments, but not less than 10 locks. Apply the padlock attachments to circuits (as directed in the field) for which the branch circuit device must be lockable in the "off" position in order to provide code-approved disconnect means.

## 2.8 PANELBOARD SHORT CIRCUIT RATINGS

- A. Panelboards and Panelettes (load centers) shall bear U.L. labels attesting to the adequacy of the equipment to withstand and interrupt short-circuit currents not less than those available at their incoming terminals. Panels shall either be fully rated or shall be series rated in conjunction with integral or remote upstream devices in compliance with Division 16 Section "Selection of Overcurrent Devices". U.L. labels shall include size and type of allowable upstream and branch circuit devices and series connected ratings.
- B. Panelboard short circuit ratings shall comply with the coordination study per specification section 16055.
- C. EMERGENCY SYSTEMS AND LEGALLY REQUIRED STANDBY SYSTEMS: Overcurrent devices shall be selected such that distribution system is selectively coordinated. Series rated devices shall not be used for distribution, regardless of any indication to the contrary. Short circuit rating of panelboards and devices shall be as required for a fully rated system. For lighting and appliance panelboards which are not available with integral main overcurrent devices, provide individually enclosed main device located adjacent to panel complete with interconnecting circuitry.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim 74 inches (188 cm) above finished floor, unless otherwise indicated.
- C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- D. Install overcurrent protective devices and controllers.

1. Set field-adjustable switches and circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. Stub four 1-inch (DN 25) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (DN 25) empty conduits into raised floor space or below slab not on grade.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

### 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. 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.
  2. 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 20 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. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  2. 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. In 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

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**SECTION 16500 - 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.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
  - 1. Division 16 Section "Basic Electrical Materials and Methods".
  - 2. Division 16 Section "Supporting Devices".
  - 3. Division 16 Section "Lighting Control Devices".
  - 4. Division 16 Section "Wiring Devices".

**1.2 SUMMARY**

- A. This Section includes interior and exterior light fixtures, emergency lighting units, exit signs, lamps, ballasts and accessories.

**1.3 SUBMITTALS**

- A. For each type of light fixture, emergency lighting unit, or exit sign specified submit data on standard features and accessories, and the following:
  - 1. Outline drawings indicating fixture dimensions.
  - 2. Catalogue cuts for proposed lamps.
  - 3. Performance data for proposed fluorescent and high intensity discharge ballasts.
  - 4. Battery and charger data for emergency lighting units.
  - 5. For air handling fixtures, submit air, thermal, and sound performance data. Provide certified results of independent laboratory tests indicating:
    - (a) Airflow as a function of pressure differential between plenum and occupied space.
    - (b) Noise criteria (NC) rating as a function of airflow.

- (c) Heat transfer rate as a function of airflow (required for heat removal fixtures only).
- B. For nonstandard fixtures, submit detailed shop drawings indicating dimensions, materials, weights, method of field installation and assembly, method of relamping and ballast access, and principal features.
- C. Submit project-specific, factory-produced shop drawings for all fluorescent pendants and continuous fluorescent wall-slots. Drawings show housing lengths, joiners, supports, endcaps, corners, and unlighted end sections, as applicable, for all unique row lengths.
- D. Submit dimming ballast compatibility certificates signed by the lighting control system manufacturer certifying that proposed dimming ballasts are compatible with proposed dimming systems.
- E. Submit samples of fixtures as directed by Architect, Engineer, or Lighting Designer. Unless otherwise noted, all samples are provided with specified lamp(s) and ballast(s), and are equipped with a cord and plug for operation at 120V.
- F. If shop drawings are submitted for a specific fixture type by a non-specified manufacturer, and approvals cannot be obtained by the third submission, then the proposed equipment will not be accepted and the specified equipment is furnished.

#### 1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70 as amended by state and local codes.
- B. Electrical Components of fixtures are listed and labeled by UL where applicable.
- C. Provide fixtures and accessory components specified in this Section that are listed and labeled for their indicated use and installation conditions on Project.
  - 1. Fixtures specified for installation in damp or wet locations are listed and labeled for use in such locations.
  - 2. Fixtures specified for installation in insulated ceilings are IC-rated if insulation comes within 3 inches (76 mm) of sides of fixture housings, or within 6 inches (152 mm) of top of fixture housings.
  - 3. Fixtures specified for installation in hazardous locations conform to UL 844.
  - 4. Comply with UL 1570-1574.
- D. The Terms "Listed" and "Labeled" are used here as per the definitions in the National Electrical Code, Article 100.

## 1.5 COORDINATION

- A. For ceiling-mounted fixtures, coordinate fixtures, mounting hardware, and trim with ceiling system and other items, including work of other trades, which must be mounted on ceiling or in ceiling space.
- B. Lighting fixtures, ballasts, lamps and other components meet or exceed the requirements of all applicable federal, state, and/or municipal energy codes.
- C. Coordinate lamps and dimming ballasts with lighting control systems. Before ordering any equipment, verify with manufacturers that proposed dimming ballasts are compatible with proposed lighting controls, and that proposed lamps are compatible with proposed dimming ballasts.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Subject to compliance with project requirements, fixtures that may be incorporated into the Work include, but are not limited to, the products specified in the Light Fixture Schedule. Where three or more manufacturers are indicated for each fixture type, no other manufacturers will be considered. Where one manufacturer is indicated for each fixture type, other manufacturers will be considered only if the engineer, architect, or lighting consultant can determine that the proposed equipment is equal to the specified equipment.

### 2.2 LIGHT FIXTURES AND FIXTURE COMPONENTS, GENERAL

- A. Light fixtures and components are suitable for operation at the voltage of the building circuits to which they are connected.
- B. Light fixtures are furnished complete with all appurtenances necessary for their proper operation, installation, and support.
- C. Light fixtures conform to the following standards as applicable:
  - 1. Fluorescent Fixtures conform to UL 1570.
  - 2. Incandescent Fixtures conform to UL 1571.
  - 3. High Intensity Discharge (HID) Fixtures conform to UL 1572.
  - 4. Track-Lighting Systems conform to UL 1574.
  - 5. Exit Signs and emergency lighting fixtures shall conform to UL 924.
  - 6. Christmas-Tree and Decorative-Lighting Outfits conform to UL 588.
- D. General Construction:
  - 1. Light fixtures are constructed with joints made only by means of welded, brazed, screwed, or bolted construction methods. Soldered joints will not be permitted. No self-tapping screws, bled metal tapping methods, or rivets are employed for fastening any parts to or in any wireway or wiring chamber,

for fastening any parts which must be removed to gain access to electrical components requiring service or replacing, or for fastening any electrical component or support for same.

2. All ferrous parts and supports, other than parts manufactured of stainless steel, are completely rustproofed after fabrication, and before finish coatings are applied. Rustproofing is by means of galvanizing, bonderizing, zinc plating, or by treatment with other industry standard rust-preventing processes providing rustproofing qualities equal to the processes mentioned above.
  3. All screws, bolts, nuts and other fastening and latching hardware are cadmium or equivalent plated.
  4. All metallic cast or extruded parts are close grained, sound, and free from imperfections or discolorations. Cast or extruded parts are rigid, true to pattern, and of ample weight and thickness. Cast or extruded parts are properly fitted, filed, ground buffed, and chased to provide finished surfaces and joints free of imperfection with all details or ornamentation brought out. Finished thickness of all cast parts is not less than 1/8 inch (3 mm).
  5. Housings are constructed so that all electrical components are easily accessible and replaceable without removing housings from their mountings.
- E. Sheet metal components are fabricated of steel, except as indicated. Form and support sheet metal to prevent warping and sagging.
- F. Doors, frames, and other means of internal access operate smoothly, free from light leakage under operating conditions, and are arranged to permit relamping without use of tools, unless indicated otherwise on drawings. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.
- G. Specular, semi-specular, and laminated silver metallized film reflectors have a non-iridescent coating when used with triphosphor fluorescent lamps. Reflectors have total hemispheric reflectances equal to or greater than the following values, unless otherwise noted:
1. White surfaces: 90 percent.
  2. Specular surfaces: 87 percent.
  3. Semi-specular surfaces: 84 percent.
  4. Laminated silver metallized films: 95 percent.
- H. Lenses and diffusers are 100 percent virgin acrylic, tempered annealed glass, or cast glass unless otherwise noted. When polycarbonate lenses are specified, they have a high resistance to yellowing or brittleness due to exposure to heat or ultraviolet radiation. Polystyrene lenses are not provided under any circumstances. Lens thickness is at least 1/8 inch (3mm), unless otherwise noted.

- I. Fixture support components comply with Division 16, Section "Supporting Devices"
  - 1. Single-stem hangers are 1/2-inch (13mm) minimum diameter steel or aluminum tubing with swivel ball fitting and ceiling canopy arranged so that stems hang vertically regardless of the angle of the surface they are mounted from. Finish of stems and canopy plates are same as fixture unless otherwise noted.
  - 2. Hook hangers are only provided where specified. Hook hangers are integrated assemblies matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
  - 3. Provide pendant mounting hardware for fixture types indicated as suitable for surface or pendant mounting in accordance with instructions issued during construction or as required by job conditions.
  - 4. Wherever a fixture or its hanger canopy is applied to a surface mounted outlet box, a finishing ring (escutcheon) is utilized to conceal the outlet box.
  - 5. Unless otherwise noted, linear fluorescent pendants are provided with aircraft cable supports, with power fed through a single straight white cord at one end of each row. When multiple independent feed points are required to satisfy circuitry requirements (e.g. when a continuous pendant row has both emergency and normal sections), locate feeds at two ends of row.
- J. Lampholders are suitable for operation of the specified lamps and are set so that lamps are positioned in optically correct relation to all light fixture components. All lampholders comply with applicable requirements of ANSI C81. All fluorescent lampholders comply with UL 542.
- K. Fixtures for use in damp or wet locations are suitably gasketed to prevent the entrance of moisture.
- L. Air-handling fixtures comply with the following:
  - 1. Sound Transmission Class (STC) conform to ADC Standard AD 63.
  - 2. Supply Units are equipped with slots in one or both side trims and joined with air-diffuser boot assemblies specified in Division 15.
  - 3. Heat Removal Units provide an air path through the lamp cavity to reduce heat buildup.
  - 4. Air Return Units are equipped with slots on either side of the diffuser to allow air return through fixture into ceiling plenum.
  - 5. Static Fixtures have slots blanked, with fixture appearance matching active units.
- M. Fixtures utilizing ballasts or transformers bear identification, by means of a label on the reflector or body, of the circuit voltage at which they are intended to operate.

- N. All high intensity discharge (HID) fixtures circuited for emergency operation are equipped with auxiliary instant-on quartz systems (also known as a quartz restrike systems). Each fixture is equipped with an auxiliary quartz lamp that is automatically switched on whenever the fixtures are energized (e.g. after a temporary power interruption) and automatically switched off when the high intensity discharge lamp reaches approximately 60 percent light output. The control circuitry that switches the quartz lamp is integral to the fixture.
- O. Recessed incandescent lighting fixtures incorporate integral thermal protection. When specified in fixture schedule, provide fixtures with special wattage reduction labels for compliance with energy codes.
- P. All components of track lighting systems, including track, fittings, and fixtures, are provided by one manufacturer.
- Q. Fixtures are complete with all internal wiring and all flexible conduits, pigtails, and the like necessary for external connections. All wire utilized for connections to or between individual lamp sockets and lamp auxiliaries (i.e., wires which do not constitute "through circuit" wiring) are minimum #16 gauge, industry standard, fixture wire suitable for the temperature, current and voltage conditions to which it is subjected. Internal wiring contains a minimum number of splices. Splices in internal wiring are made with approved insulated "wire nut" type mechanical connectors, suitable for the temperature and voltage conditions to which they are subjected.
- R. Grounding-type flexible conduit is used for light fixture pigtails, and grounding type connectors are used for installing same. Include grounding conductor if upstream overcurrent device exceeds 20 amps.
- S. Fluorescent fixtures specified with integral emergency battery packs (also known as emergency ballasts) incorporate a test switch and indicator light within the fixture. Test switch and indicator light are discretely located, so that they are not visible from ordinary viewing angles, but so that they are readily accessible to maintenance personnel, as required by code. Fixtures incorporating emergency battery packs are wired so that they may be switched or dimmed as part of their assigned lighting control zone without causing the battery pack to energize the lamps.

## 2.3 BALLASTS

- A. General Requirements: Provide ballasts as indicated in the Light Fixture Schedule. If specific ballasts are not identified in the Light Fixture Schedule, provide ballasts as indicated below:
  - 1. Fixtures with T-8 linear and U-bent fluorescent lamps are provided with instant start solid-state electronic ballasts.
  - 2. Fixtures with T-5 standard and high-output linear fluorescent lamps are provided with programmed rapid start solid-state electronic ballasts.
  - 3. Fixtures with T-5 "biax" 2G11-base lamps (excluding NEMA FT40W) are provided with programmed rapid start solid-state electronic ballasts.

4. Fixtures with 40W T-5 "biax" 2G11-base lamps (NEMA FT40W) are provided with instant start solid-state electronic ballasts.
  5. Fixtures with T-4 "quad tube" and "triple tube" compact fluorescent lamps (NEMA CFQ and CFM) are provided with programmed rapid start solid-state electronic ballasts.
  6. Fixtures with T-4 "twin tube" compact fluorescent lamps rated 13W or lower (NEMA CFT13W, CFT9W, and CFT7W) are provided with preheat electromagnetic ballasts.
  7. Fixtures with HID lamps are provided with electromagnetic ballasts.
- B. Instant start electronic ballasts comply with the following:
1. Ballasts for T-8 lamps operate from a 50/60 Hz input source of 108-305 volts with no damage to the ballasts.
  2. Input current Total Harmonic Distortion (THD) does not exceed 10 percent.
  3. Power factor is 0.90 or greater.
  4. Provide 2-, 3-, or 4-lamp ballasts for multilamp fixtures wherever possible. All multilamp ballasts operate lamps in parallel, so that the loss of one or more lamps will not prevent the remaining lamps from functioning properly.
  5. Ballast factor is between 0.85 and 0.90 for normal light output ballasts, and a minimum of 1.15 for high light output ballasts. Provide normal light output ballasts unless otherwise specified.
  6. Ballasts operate lamps at a frequency of 40 kHz or greater.
  7. Ballasts are UL 935 Listed, Class P, Type 1 Outdoor, and CSA certified where applicable.
  8. Ballasts meet ANSI C82.11.
  9. Ballasts comply with the Federal Communications Commission rules and regulations, Title 47 CFR Part 18 Non-Consumer Equipment for EMI (power line conducted) and RFI (radiated).
  10. Ballasts withstand transients as specified in ANSI C62.41.
  11. Ballasts have class "A" sound rating.
  12. Lamp current crest factor is less than 1.7.
  13. Ballasts operate lamps with no visible flicker (3 percent flicker index).
  14. Ballasts start and operate T-8 lamps down to 0 degrees Fahrenheit (-18 degrees Celsius) or lower without shortening lamp life.



15. Ballasts are warranted for a minimum of five years. Ballast manufacturer provides replacement ballast and pays all labor costs associated with replacing ballasts that fail during their warranty period.
16. Ballasts are manufactured by one of the following: Universal "Triad HP", Osram/Sylvania "Quicktronic Professional", or Advance "Centium".

C. Programmed rapid start electronic ballasts comply with the following:

1. Ballasts are suitable for operation at the voltage and frequency of the building circuits to which they are connected, and sustained variations of +/- 10 percent (voltage and frequency) with no damage to the ballasts.
2. Input current Total Harmonic Distortion (THD) does not exceed 10 percent.
3. Power factor is 0.90 or greater.
4. Ballasts incorporate lamp shutdown circuitry for end of lamp life protection.
5. Ballast factor is between 0.95 and 1.05.
6. Ballasts operate lamps at a frequency of 40 kHz or greater.
7. Ballasts are UL 935 Listed, Class P, Type 1 Outdoor, and CSA certified where applicable.
8. Ballasts meet ANSI C82.11.
9. Ballasts comply with the Federal Communications Commission rules and regulations, Title 47 CFR Part 18 Non-Consumer Equipment for EMI (power line conducted) and RFI (radiated).
10. Ballasts withstand transients as specified in ANSI C62.41.
11. Ballasts have class "A" sound rating.
12. Lamp current crest factor is less than 1.7.
13. Ballasts start and operate lamps down to 0 degrees Fahrenheit (-18 degrees Celsius) or lower without shortening lamp life.
14. Ballasts are warranted for a minimum of five years. Ballast manufacturer provides replacement ballast, and pays all labor costs associated with replacing ballasts that fail during their warranty period.
15. Ballasts for T-5 standard and high output linear fluorescent lamps are manufactured by one of the following: Universal "Triad PRS", Osram/Sylvania "Quicktronic Professional PROStart", or Advance "Centium".

16. Ballasts for T-8 linear and U-bent fluorescent lamps be manufactured by one of the following: Universal "Accustart", Osram/Sylvania "Quicktronic Professional PROStart", or Advance "Mark V".
  17. Ballasts for T-5 "biax" 2G11-base lamps (excluding NEMA FT40W) are manufactured by one of the following: Universal "Triad PRS" or Advance "Centium".
  18. Ballasts for compact fluorescent lamps are manufactured by one of the following: Universal "Triad PRS", Osram/Sylvania "Quicktronic Professional CF Universal", or Advance "Smartmate".
- D. Preheat electromagnetic compact fluorescent ballasts comply with the following:
1. Ballasts are encapsulated or potted to ensure maximum thermal and structural integrity.
  2. Power factor is 0.90 or greater.
  3. Ballast factor is between 0.95 and 1.05.
  4. Ballasts are warranted for a minimum of two years. Ballast manufacturer provides replacement ballast and pays all labor costs associated with replacing ballasts that fail during their warranty period.
  5. Ballasts are manufactured by Universal, Advance, or Robertson Worldwide.
- E. Fluorescent dimming ballasts are solid-state electronic, providing smooth and continuous dimming over a minimum range of 100 percent light output to 1 percent light output unless connected to a daylight harvesting system. Ballasts connected to daylight harvesting systems dim lamps over a range of 100 percent light output to 10 percent light output. Dimming ballasts are endorsed by the manufacturer of the lighting control system to which they are connected. Unless otherwise noted, dimming ballasts are Lutron Hi-Lume or Lightolier PowerSpec HDF. Lutron ECO-10 ballasts area acceptable when connected to daylight harvesting systems.
- F. Electromagnetic core and coil ballasts for HID lamps are combined with appropriate capacitors and starters, referred to collectively as ballast assemblies, for operation of specified lamps. Ballast assemblies comply with the following:
1. Ballast assemblies for HID lamps rated 100W or higher are constant-wattage autotransformer (CWA) type.
  2. Ballast assemblies for HID lamps rated less than 100W are high-reactance autotransformer (HX-HPF) type.
  3. Power factor is 0.90 or greater.
  4. Ballast factor is 1.0.
  5. Ballasts are designed in accordance with all applicable ANSI specifications, including ANSI C82.4.

6. Core and coil ballasts are designed with class "H" (180 degree Celsius) or higher insulation system and vacuum impregnated with resin.
  7. Core and coil ballast and starter combinations are designed to provide reliable lamp starting down to negative 40 degrees Fahrenheit (negative 40 degrees Celsius) for High Pressure Sodium lamps and negative 20 degrees Fahrenheit (negative 30 degrees Celsius) for Metal Halide lamps.
  8. Ignitors are designed to provide six months of lamp open circuit operation without failure.
  9. Ballast assemblies are warranted for a minimum of two years. Manufacturer provides replacement ballast assembly, and pays all labor costs associated with replacing ballast assemblies that fail during their warranty period.
  10. Ballasts are manufactured by Universal, Advance, Venture, or Robertson Worldwide.
- G. Electronic ballasts for Metal Halide lamps comply with the following:
1. Ballasts operate from a 50/60 Hz input source of 108-305 volts with no damage to the ballasts.
  2. Input current Total Harmonic Distortion (THD) does not exceed 15 percent.
  3. Power factor is 0.90 or greater.
  4. Ballast is thermally protected and incorporate lamp shutdown circuitry for end of lamp life protection.
  5. Ballast factor is 1.0.
  6. Ballasts operate lamps at a frequency of less than 200 Hz.
  7. Ballasts comply with the Federal Communications Commission rules and regulations, Title 47 CFR Part 18 Non-Consumer Equipment for EMI (power line conducted) and RFI (radiated).
  8. Ballasts have class "A" sound rating.
  9. Lamp current crest factor is less than 1.5.
  10. Ballasts are designed to provide reliable lamp starting down to negative 20 degrees Fahrenheit (negative 30 degrees Celsius).
  11. Ballasts are warranted for a minimum of five years. Ballast manufacturer provides replacement ballast, and pays all labor costs associated with replacing ballasts that fail during their warranty period.
  12. Ballasts are manufactured by one of the following: Aromat, or Advance "e-Vision".

- H. Emergency battery packs (also known as emergency ballasts): An emergency battery pack incorporates a battery, charger, inverter circuit, and control electronics into one housing. Emergency battery packs comply with the following:
1. The emergency battery packs are designed to work in conjunction with the standard AC ballast in the fixture, and with an indicator light and test switch provided by the manufacturer of the battery pack.
  2. Emergency battery packs are UL 924 Listed, and meet or exceed all National Electrical Code (NFPA-70) and Life Safety Code (NFPA-101) emergency lighting requirements.
  3. Emergency battery packs incorporate maintenance-free Nickel-Cadmium (Ni-Cad) batteries.
  4. Emergency battery packs are designed to provide a minimum of 90 minutes of emergency illumination. Provide longer duration when required by code.
  5. Unless otherwise specified, emergency battery packs provide the following minimum initial lumen output per battery pack:
 

Lamp Type	Lumens
T-8, T-5	825
T-5 High Output	1,300
T-5 "biax" 2G11-base	825
Compact Fluorescent	650
  6. Emergency battery packs are warranted for a minimum of five years. Manufacturer provides replacement emergency battery pack and pays all labor costs associated with replacing emergency battery packs that fail during their warranty period.
  7. Emergency battery packs are manufactured by Iota Engineering or Bodine.

## 2.4 LAMPS

- A. Conform to the ANSI C78 series that is applicable to each type of lamp.
- B. Incandescent Lamps:
1. Unless otherwise noted, all 37W and 50W MR16 lamps are Osram/Sylvania "Tru-Aim IR". All other MR16 lamps are GE "Constant Color", Osram/Sylvania "Tru-Aim Titan", or Philips "Continuum Color" to insure consistent color. All MR16 lamps have an integral clear cover glass lens.
  2. Unless otherwise noted, all 50W, 60W, and 100W PAR38 lamps, and all 50W PAR30 lamps incorporate "halogen infrared" technology, by the following manufacturers: GE "HIR", Philips "IRC", or Osram/Sylvania "IR".

C. Fluorescent lamps (T-8, T-5, and T-5 2G11-base):

1. Rated average life is a minimum of 20,000 hours when operated three hours per start. A shorter rated average life is acceptable for 50W and 55W T-5 2G11-base lamps only.
2. Unless otherwise noted, lamp phosphors are a composition that includes rare earth phosphors, with a correlated color temperature (CCT) of 3500 degrees Kelvin and a color rendering index (CRI) of not less than 80 (NEMA designation RE 835).
3. All T-8 linear fluorescent lamps are TCLP-compliant. Provide only GE "Ecolux", Philips "ALTO", or Osram/Sylvania "Ecologic" lamps.

D. Compact fluorescent lamps (T-4):

1. Rated average life is a minimum of 10,000 hours when operated at three hours per start.
2. Lamp phosphors are a composition that includes rare earth phosphors, with a correlated color temperature (CCT) of 3,000 degrees Kelvin and a color rendering index (CRI) of not less than 80 (NEMA designation RE 830).
3. T-4 "twin tube" compact fluorescent lamps rated 13W or lower (NEMA CFT13W, CFT9W, and CFT7W) have two-pin bases. Four-pin bases are required for all other compact fluorescent lamps.

E. Metal Halide Lamps:

1. Unless otherwise noted, all 20W, 39W, 50W, 70W, and 100W lamps incorporate ceramic arc tube technology. Provide only Philips "Mastercolor" or GE "CMH" lamps.
2. "Pulse Start" lamps, where specified, are combined with an appropriate ballast assembly to achieve manufacturer's rated performance.
3. Provide lamps with the highest color rendering index (CRI) available at the specified correlated color temperature (CCT). The minimum CRI for coated lamps is 70, and the minimum CRI for clear lamps is 65.
4. Provide "protected" or "open rated" lamps for use in all open fixtures.

F. All lamps are manufactured by GE, Osram/Sylvania, Philips, or Venture.

## 2.5 FINISHES

- A. Provide metal finishes and paint colors as selected by the Architect.
- B. Where a "Custom Color Finish" is specified but not identified, match sample provided by Architect.
- C. Apply paint finishes over corrosion-resistant treatment or primer, free of streaks, runs, stains, blisters, and similar defects.

- D. When the Architect issues no instructions pertaining to finishes, provide standard finishes as follows:
1. Unpainted non-reflecting surfaces are satin finished and coated with a baked-on clear lacquer to preserve the surface. Where aluminum surfaces are treated with an anodic process, the clear lacquer coating may be omitted.
  2. Enamel coatings are of the high temperature baked-on type. Enamel reflecting surfaces are white with 90 percent minimum initial reflectance.
  3. Porcelain enameled finishes meet or exceed R.L.M. standards in all respects.
  4. Painted surfaces on fixtures for use outdoors or in damp locations exhibit weather and moisture resisting qualities equal to surfaces having epoxy based coatings. Unpainted aluminum are anodized.
  5. Unpainted aluminum reflecting surfaces are treated with an Alzak or anodizing process to insure a permanent reflective surface with a minimum 87 percent reflectance.

## 2.6 EXIT SIGNS

- A. Exit signs comply with the following:
1. Color, letter height, and letter stroke comply with all requirements of applicable state and local building codes.
  2. Edge-lit exit signs which are visible from two directions have a mylar film inserted in the center of the panel, so that the letters are not visible from the wrong direction.
- B. Self-illuminated exit signs equipped with integral battery packs for emergency operation comply with the following:
1. The battery is a sealed, maintenance-free nickel-cadmium battery with a five-year warranty.
  2. The charger is solid-state, fully automatic with a sealed transfer relay.
  3. When the input voltage drops to 80 percent of normal or below, the relay energizes the lamps from the battery pack, instead of the normal building power. When normal power is restored, the relay energizes the lamps from the normal building power, automatically recharge the battery, and float it on the charger.

## 2.7 LIGHTING CONTROLS

- A. Lighting controls including - but not limited to - switches, occupancy sensors, photoelectric sensors, timeclocks, dimmers, relays, panels, and other miscellaneous devices are provided as part of the electric work.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Set light fixtures plumb, square, and level with ceiling, walls, and/or ground and secure according to manufacturer's written instructions and approved Shop Drawings. Support fixtures according to requirements of Division 16 Section "Supporting Devices"

- B. Fixtures suspended more than 48 inches (1200mm) below ceiling are braced to limit swinging.
- C. When lamps are not specified, lamp units according to manufacturer's instructions.
- D. Light fixture locations shown on electrical drawings are approximate. For light fixtures in building equipment rooms (Mechanical, Electrical, Telecommunications, etc.), coordinate fixture locations with equipment, so that optimal light distribution is obtained, without obstructing access to equipment. All other light fixtures are installed as shown on architectural drawings, or as directed by Architect.
- E. Fixtures with asymmetric light distributions are oriented as shown in manufacturer's installation instructions. When manufacturer's instructions are not clear, obtain clarification from Architect before proceeding with installation.

### 3.2 CONNECTIONS

- A. Ground light fixtures. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.3 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Verify normal operation of each fixture after fixtures have been installed and circuits have been energized with normal power source. Interrupt electrical power to demonstrate proper operation of emergency lighting.
- C. Repair and retest malfunctioning fixtures and components. Repeat procedure until all units operate properly.
- D. Replace fixtures that show evidence of corrosion during Project warranty period.
- E. All permanent light fixtures used for temporary light during the construction phase for a period over 1,000 hours for fluorescent and HID sources and 100 hours for incandescent are relamped prior to acceptance.

### 3.4 ADJUSTING AND CLEANING

- A. Clean fixtures after installation. Use methods and materials recommended by manufacturer.
- B. Adjust aimable fixtures to provide required light intensities. Aim all adjustable fixtures after dark, under the direction of Lighting Consultant, Architect, or Engineer.

### 3.5 SPARES

A. Provide spare components to Owner at completion of project as outlined below:

1. For fluorescent, compact fluorescent, and HID lamps, provide one spare of each type for every ten installed (ten percent spare). Provide a minimum of four spare lamps of each type.
2. For incandescent lamps, provide one spare of each type for every five installed (twenty percent spare). Provide a minimum of four spare lamps of each type.
3. For ballasts and transformers, provide one spare of each type for every twenty installed (five percent spare). Provide a minimum of one spare of each type.
4. For interior lenses, louvers and diffusers, provide one spare of each type for every twenty-five installed (four percent spare). Provide a minimum of one spare of each type.

END OF SECTION 16500



**NEW PASSENGER TERMINAL  
DULUTH INTERNATIONAL AIRPORT  
DULUTH, MINNESOTA**

**SECTION 16714 - COMMUNICATIONS  
EQUIPMENT ROOM FITTINGS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Telecommunications mounting elements.
  - 2. Backboards.
  - 3. Telecommunications equipment racks and cabinets.
  - 4. Telecommunications service entrance pathways.
  - 5. Grounding.
- B. Related Sections:
  - 1. Division 16 Section 16710 "Premise Distribution System."
  - 2. Division 16 Section 16716 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
  - 3. Division 16 Section 16717 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

**1.3 DEFINITIONS**

- A. BICSI: Building Industry Consulting Service International.
- B. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
- C. LAN: Local area network.
- D. RCDD: Registered Communications Distribution Designer.

**1.4 SUBMITTALS**

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

- 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
  - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
- C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
  - 1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
  - 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
  - 3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
- D. Grounding: Comply with ANSI-J-STD-607-A.

## 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

## 1.7 COORDINATION

- A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
  - 1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
  - 2. Record agreements reached in meetings and distribute them to other participants.
  - 3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
  - 4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

- B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

## PART 2 - PRODUCTS

### 2.1 PATHWAYS

- A. General Requirements: Comply with TIA/EIA-569-A.
- B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.
  - 1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
  - 2. Support brackets with cable tie slots for fastening cable ties to brackets.
  - 3. Lacing bars, spools, J-hooks, and D-rings.
  - 4. Straps and other devices.
- C. Cable Trays:
  - 1. Refer to Section 16127 "Cable Trays" for specification information.
- D. Conduit and Boxes: Comply with requirements in Division 16 Section "Raceways and Boxes." Flexible metal conduit shall not be used.
  - 1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

### 2.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels specified in Division 6 Section "Rough Carpentry."
- B. Provide prefabricated backboard as indicated on the drawings.

### 2.3 EQUIPMENT FRAMES

- A. Manufacturers: Subject to compliance with requirements of paragraph 1.2 C of Section 16710, provide products by one of the following:
  - 1. ADC.
  - 2. Aim Electronics; a brand of Emerson Electric Co.
  - 3. AMP; a Tyco International Ltd. company.
  - 4. Cooper B-Line, Inc.
  - 5. Hubbell Premise Wiring.
  - 6. KRONE Incorporated.
  - 7. Leviton Voice & Data Division.
  - 8. Middle Atlantic Products, Inc.
  - 9. Nordex/CDT; a subsidiary of Cable Design Technologies.
  - 10. Ortronics, Inc.
  - 11. Panduit Corp.
  - 12. Siemon Co. (The).
- B. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
  2. Module Dimension: Width compatible with EIA 310 standard, 19-inch (480-mm) panel mounting.
  3. Finish: Manufacturer's standard, baked-polyester powder coat.
- C. Floor-Mounted Racks: Modular-type, steel or aluminum construction.
1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
  2. Baked-polyester powder coat finish.
- D. Modular Freestanding Cabinets:
1. Removable and lockable side panels.
  2. Hinged and lockable front and rear doors.
  3. Adjustable feet for leveling.
  4. Screened ventilation openings in the roof and rear door.
  5. Cable access provisions in the roof and base.
  6. Grounding bus bar.
  7. Rack-mounted, 550-cfm (260-L/s) fan with filter.
  8. Power strip.
  9. Baked-polyester powder coat finish.
  10. All cabinets keyed alike.
- E. Modular Wall Cabinets:
1. Wall mounting.
  2. Steel or aluminum construction.
  3. Treated to resist corrosion.
  4. Lockable front and rear doors.
  5. Louvered side panels.
  6. Cable access provisions top and bottom.
  7. Grounding lug.
  8. Rack-mounted, 250-cfm (118-L/s) fan.
  9. Power strip.
  10. All cabinets keyed alike.
- F. Cable Management for Equipment Frames:
1. Metal, with integral wire retaining fingers.
  2. Baked-polyester powder coat finish.
  3. Vertical cable management panels shall have front and rear channels, with covers.
  4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

## 2.4 POWER STRIPS

- A. Power Strips: Comply with UL 1363.
1. Rack mounting.
  2. Six 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
  3. LED indicator lights for power and protection status.
  4. LED indicator lights for reverse polarity and open outlet ground.
  5. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.

- 6. Close-coupled, direct plug-in line cord.
- 7. Rocker-type on-off switch, illuminated when in on position.

## 2.5 GROUNDING

- A. Comply with requirements in Division 16 Section "Grounding and Bonding" for grounding conductors and connectors.
- B. Telecommunications Main Bus Bar:
  - 1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
  - 2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.
  - 3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.
- C. Comply with ANSI-J-STD-607-A.

## 2.6 LABELING

- A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

# PART 3 - EXECUTION

## 3.1 ENTRANCE FACILITIES

- A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and housing when so directed by service provider.
- B. Install underground pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Article.
  - 1. Install underground entrance pathway complying with applicable Division 16 Sections.

## 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- C. Cable Trays: Comply with Specification Section 16127 and TIA/EIA-569-A-7.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

### 3.3 FIRESTOPPING

- A. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."
- B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

### 3.4 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with ANSI-J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
  - 1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

### 3.5 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 16 Section "Electrical Identification."
- B. Comply with requirements in Division 9 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 3 level of administration including optional identification requirements of this standard.
- D. Labels shall be preprinted or computer-printed type.

END OF SECTION 16714

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**SECTION 16715 – COMMUNICATIONS  
NETWORK EQUIPMENT**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Local Area Network Hardware.
  - 2. Wireless Network.
  - 3. Network Management.
  - 4. Configuration.
  - 5. Device and Cable Identification
  - 6. System Warranty

**1.3 FUNCTIONS AND PERFORMANCE REQUIREMENTS**

- A. Firewall: The new network design shall incorporate a firewall between the airport and the outside world. VPN access shall be created for remote access by the Owner and Integrator for testing and maintenance.
- B. Pre-Configuration: Provide pre-configuration of all equipment before deploying it in the field.
- C. Field Configuration: Provide addition field configuration of the network to provide optimized network services for all users.
- D. Network Monitoring: A comprehensive on-site network monitoring system shall be put in place, which will ensure that all key services are functional. Further refinements shall track service degradation in other areas, provide enhanced alerting, and allow for long-term tracking of resource allocation. The network monitoring system shall monitor and manage the following critical systems:
  - 1. UPS system.
  - 2. Access Control Hardware.
  - 3. CCTV Hardware.
  - 4. Wireless Devices.
  - 5. Temperature Sensors.

**1.4 SUBMITTALS**

- A. Product Data: For each type of product indicated on the drawings and specifications.
- B. Shop Drawings: Provide complete shop drawings which include the following:
  - 1. Indicate all system device locations on scaled plans.

2. Include full schematic wiring information on these drawings for all devices. Wiring information shall include cable type, conductor routings, quantities, and connection details at device.
  3. Include a complete one-line, block diagram.
  4. Include a statement of the system sequence of operation of each device and overall system performance.
- C. Qualification Data: For Project Manager and network implementation engineers.
- D. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
  2. Device address list.
  3. Printout of software application and graphic screens.
- E. Wireless Network Report
- F. Project Close-out Submittal:
1. Provide three sets of hard copy manuals and three sets electronic format manuals including operating instructions, maintenance recommendations and parts list including wiring and connection diagrams modified to reflect as-built conditions.
  2. Final copies of the manuals shall be delivered within 30 days after completing the installation test. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following
    - a. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included.
    - b. Hardware Manual: The manual shall describe all equipment furnished including:
      - 1) General description and specifications
      - 2) Installation and check out procedures
      - 3) Equipment layout and electrical schematics to the component level
      - 4) System layout drawings and schematics
      - 5) Alignment and calibration procedures
      - 6) Manufacturers repair parts list indicating sources of supply
    - c. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
      - 1) Definition of terms and functions
      - 2) System use and application software
      - 3) Initialization, start up, and shut down
      - 4) Reports generation
      - 5) Details on customization and field parameters



- d. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
- 3. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the network to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the network. Copies of the final as-built drawings shall be provided to the end user in PDF format.

## 1.5 QUALITY ASSURANCE

- A. The system contractor / integrator responsible for providing the network shall have at least ten (10) years experience in furnishing and installation of such systems.
- B. The system contractor's project manager and on-site superintendent shall have a minimum of fifteen (15) years experience and shall have worked on the projects in similar capacity.
- C. Manufacturer Qualifications
  - 1. Manufacturer of the network hardware shall be an established organization with referenced and documented experience delivering and maintaining network system of equal or higher sophistication and complexity as compared to the system detailed in this specification.
  - 2. Manufacturer's manufacturing facilities shall be certified ISO-9000:2000 operations, utilize ISO-9000:2000 manufacturing procedures and maintain their ISO certifications.
  - 3. Manufacturer shall employ at a minimum the following methods for QA of component and assembly devices.
    - a. Visual inspection of devices shall be performed to verify assembly according to defined procedures. End of line operational tests shall be performed to ensure product functionality has been correctly configured. A system burn-in period shall be utilized to screen for early life failures of electronic components.
  - 4. Individual functionality and system level regression testing shall be performed to ensure compliance with product specifications. Single and multiple unit system tests shall be performed to mimic end-user installation configurations. Automated hardware and software testing shall be utilized to evaluate system performance under published operational loads and shall be compared to published system capabilities.
- D. Network installer experience: The network system integrator / contractor shall have factory trained personnel from the approved manufacturer with a minimum of five (5) years experience in system integration and a minimum of two (2) years experience in the proposed network systems for this project. Submit names of the qualified personnel.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Test equipment upon receipt at Project site. Store and handle as required by manufacturer's instructions.

## 1.7 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

## 1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. One network switch, mesh node and antenna of each type complete to allow easy swapping of a defective switch without requirement of new software or firmware.

## PART 2 - PRODUCTS

### 2.1 LOCAL AREA NETWORK (LAN)

- A. Provide network switches and other network components as indicated on the drawings.
- B. LAN hardware shall be Cisco or approved equal.

### 2.2 WIRELESS NETWORK (WIFI)

- A. Conduct a site survey prior to network design submission and submit results with the design.
- B. Use a wireless overlay to provide in-building roaming network connectivity. All access points shall provide 802.11 compatibility will full 54 Mbps connectivity available in 100% of all airport spaces.
- C. WEP, SSID and LEAP configuration information shall be coordinated with Owner & A/E prior to final configuration.
- D. Access Point Naming Conventions: AP Number-IDF # to which AP connects-Patch Panel Port #.

### 2.3 NETWORK CONFIGURATION AND TECHNOLOGY IMPLEMENTATION

- A. Develop and provide complete and secure network configuration for all network users and devices as indicated on drawings.
- B. The approved IT professional shall provide following services to provide an efficient secured and highly manageable network system:

1. Develop planning and implementation strategy, working with the owner, A/E and other network users, for the implementation of the network.
2. Develop LAN configuration including Quality of Service, Layer Switching and Forwarding, Multicast, Port Monitoring, Spanning Tree Protocol, VLAN Trunking Protocol and other techniques.
3. Develop Monitoring and Management procedures. Network monitoring system shall be configured to notify administrator of system modifications and provide a management policy for tracking and notification.
4. Develop Network Optimization scheme to prevent larger users of the network resources (e.g. CCTV system) from reducing network availability and efficiency. Develop QoS priorities and coordinate optimization with all systems connected to the network. Integrator shall notify A/E of any priority issues that cannot be resolved with network configurations.

## 2.4 IP ADDRESSING

- A. IP addressing ranges shall be coordinated with Owner and A/E prior to implementation.

## PART 3 - EXECUTION

### 3.1 IMPLEMENTATION

- A. Provide a detailed implementation schedule, coordinated with all network users and devices, for review and approval.
- B. Provide network services as required to meet phasing, sequencing and completion on schedule.

### 3.2 DELIVERABLES:

- A. All deliverables shall be provided electronically and in hard copy.
  1. Electronic deliverables will be sent to the Airport Network Administrator and A/E.
  2. Hard copy deliverables shall be placed in a heavy duty plastic pouch ring binder (preferred) or laminated.
  3. Specific deliverables are dependent upon scope of work; however, an asset tracking spreadsheet shall be required.

### 3.3 ACCEPTANCE CRITERIA

- A. All electronic deliverables have been received.
- B. Successfully demonstrate network management and monitoring system.
- C. Output of show interfaces command indicates that end user devices are communicating properly with network electronics. Obviously incrementing errors on an interface shall be resolved prior to acceptance.
- D. Onsite inspection is conducted.
  1. Packing material has been removed from all devices.
  2. All equipment is properly secured and mounted.

3. Velcro has been used to secure power cords and patch cables.
4. Patch cables of proper color are neatly and properly contained in wire managers or properly dressed with Velcro if wire managers are not installed.
5. Power cords from hardware to power outlets are neatly attached.
6. Hard copy deliverables are in place.
7. Check of labeling configuration indicates accuracy of documentation.
8. Outdoor penetrations and cable connections are properly weather proofed.
9. Viewing reports of network monitoring systems.

#### 3.4 MAINTENANCE SERVICES (WARRANTY)

- A. The Contractor shall provide "on-call" warranty maintenance service for all equipment supplied under this Contract for two (2) years after acceptance of the entire NETWORK EQUIPMENT (hardware and software) by Owner. The "On Call" services shall be provided by the qualified contractor and shall include combination of periodic (once every 4 months for a minimum of two days) onsite and additional 24/7 support by remote (telephone and remote log-in) access. Include additional two (2) days per year for emergency services.

END OF SECTION 16715

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**SECTION 16721 - FIRE PROTECTIVE  
ALARM SYSTEM**

**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 a Fire Protective Alarm (FPA) system of the addressable initiating device type, consisting essentially of the following components:
1. Central equipment (also referred to as head end equipment) including Fire Command Station (FCS).
  2. A graphic annunciator.
  3. Outlying analog-addressable smoke (and smoke-heat) sensor/detectors.
  4. Outlying addressable manual fire alarm stations.
  5. Outlying addressable heat detectors.
  6. Outlying sprinkler and fire standpipe alarm and supervisory devices furnished and installed separate from the work of this section.
  7. Outlying addressable modules (monitoring or control) in addressable module boxes or cabinets.
  8. Outlying loudspeaker stations; each with integrally mounted visual fire warning (strobe) except as otherwise specified.
  9. Outlying visual warning signals (strobes).
  10. Outlying intercom stations (floor warden stations).
  11. Outlying "area of rescue assistance" intercom stations.
  12. Outlying annunciator(s).
  13. Outlying system equipment control cabinets (also referred to as equipment control cabinets).
  14. Central damper control panel.

15. Interfaces with pre-action sprinkler systems, clean agent systems, or other standalone sub-systems.
  16. Printer.
  17. Interconnecting circuitry and control circuit extensions (i.e., final connections to controlled equipment from addressable module boxes).
- B. Related Sections: The following Sections contain requirements that relate to this Section:
1. Division 15 Section "Electric-Drive, Horizontal Fire Pumps" for coordinating fire alarm system interconnections.
  2. Division 15 Section "Standpipes and Hoses" for coordinating flow, pressure, and valve tamper switch requirements.
  3. Division 15 Section "Pre-action Sprinkler System" for coordinating fire alarm system interconnections.

### 1.3 DEFINITION

- A. FCS: Fire Command Station. Used interchangeably with FACP (see below)
- B. FACP: Fire Alarm Control Panel (see above).

### 1.4 SYSTEM DESCRIPTION

- A. General: Zoned, noncoded, addressable, microprocessor-based fire-detection and alarm system with manual and automatic alarm initiation, analog addressable smoke detectors, and automatic alarm verification for alarms initiated by certain smoke detector zones as indicated.
- B. Signal Transmission: Multiplex signal transmission dedicated to fire alarm service only.
- C. Audible Alarm Notification: By sounding of "alert" tone signals followed by voice messages, followed by "alarm" signals for zones as described hereinafter.
- D. Visual Alarm Notification: By xenon-strobe-type units.

### 1.5 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of system component specified including dimensioned plans and elevations showing minimum clearances and installed features and devices. Include list of materials and Underwriters Laboratories and Factory Mutual listing data.
- C. Shop Drawings showing details of graphic annunciator.

- D. Wiring diagrams from manufacturer differentiating clearly between factory- and field-installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Make all diagrams specific to this Project and distinguish between field and factory wiring.
- E. Device Address List: Coordinate with final system programming.
- F. System operation description covering this specific Project, including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are unacceptable.
- G. Operating instructions for mounting at the FACP (FCS).
- H. Product certificates signed by manufacturers of fire alarm system components certifying that their products comply with specified requirements.
- I. Maintenance data for fire alarm systems to include in the operation and maintenance manual specified in Division 1. Include data for each type of product, including all features and operating sequences, both automatic and manual. Include recommendations for spare parts to be stocked at the site. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system furnished.
- J. In addition to routine submission of above materials, make all filings with the Building Department, Fire Department, and any other agencies having jurisdiction. Where filings require the engineer's signature, documents will be submitted for his review and signature. This responsibility will include furnishing of required quantities of floor plans, descriptive notes and/or specifications, wiring diagrams, shop drawings and amendment forms, as well as the payment of any required filing fees.
- K. Permits necessary for installation of the work will be obtained prior to the commencement of the work. All permit costs and inspection fees will be included as part of the required work.
- L. Record of field tests of system.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Installing contractor has at least 5 years experience in the installation of multiplexed fire alarm systems. Provide services of a NICET Level IV technician supplied by the fire alarm system manufacturer to supervise installation, adjustments and tests of system.
- B. Single-Source Responsibility: Obtain fire alarm components from a single source who assumes responsibility for compatibility of system components.
- C. Compliance with Local Requirements: Comply with the applicable building code, local ordinances, and regulations, and the requirements of the authorities having jurisdiction.
- D. Comply with NFPA 70 as amended by state and local codes.

- E. Comply with NFPA 72.
- F. Comply with ANSI/ASME 17.1, NFPA 101 and UL 268,2196.
- G. Comply with Americans with Disabilities Act (ADA).
- H. Listing and Labeling: Provide fire alarm systems and components specified in this Section that are listed and labeled by Factory Mutual and Underwriters Laboratories.
- I. The system is complete with all components and wiring required for compliance with all applicable codes and regulations, and for its operation as described hereinafter. No exclusion from or limitation in the symbolism used on the drawings or the language used in these specifications will be interpreted as a reason for omitting any appurtenances or accessories required to enable the system to perform the specified functions.
- J. Early completion of the Fire Protective Alarm system will be required so as to permit a certificate of occupancy to be obtained in a timely manner, in accordance with a schedule established by the Architect.
- K. Upon completion of the installation (and as directed by the Architect), the work includes making all arrangements and providing any assistance necessary for inspection and test as required for approval by the Fire Department. Modifications, adjustments and/or corrective work necessary to obtain approval along with subsequent inspection and test resulting from the issuance of a "Notice of Defect" will precede any consideration of formal acceptance by the Architect. In conjunction with the above, training as deemed necessary to instruct authorized building personnel in the proper operation of the system also forms a part of the required work.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
  - 1. Edwards Systems Technology; General Signal Unit.
  - 2. Simplex Fire Alarm, Inc.
  - 3. Firecom, Inc.
  - 4. Gamewell/FCI
  - 5. Honeywell Fire Systems/Notifier
  - 6. Siemens Building Technologies, Inc.



## 2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. Include system functions and operating features as described below, plus those additional functions and features required by the authorities having jurisdiction. System design is such that neither the failure of the normal power source, the transfer to an emergency source, nor the retransfer to the normal source causes a change in system status (i.e., initiation of alarm signals or operation of equipment control relays).
- B. The central equipment of the system incorporates redundant components so that the failure of any component does not interfere with system operation as described hereinafter. Submission of the system for approval includes a detailed description of how compliance with this requirement is accomplished.
- C. System supervision is such that the ability of all addressable alarm initiating devices and addressable modules to communicate with the central equipment is constantly monitored, and such failure results in an audible signal at the Fire Command Station (FCS) and outlying annunciator(s) and a visual annunciation identifying the faulted device or module.
- D. The system utilizes liquid crystal display ( LCD) for the display of all required alarm and equipment status information, and an associated keyboard to permit manual access to the system. For fire department use, selector switch and pilot light modules are also included at the Fire Command Station for status and manual access to fans and dampers. The display is capable of displaying at least 20 lines, with 80 characters per line. System response time is such that alarm indications are displayed within 10 seconds of occurrence. No portion of the "executive" program is stored on magnetic media. It is entered into the system by means of "firmware."
- E. Smoke detection devices (variously identified herein as "smoke detectors," "smoke sensors" and "smoke sensor/detectors") are understood to be of the analog addressable smoke sensor type, for which the decision to initiate an alarm in response to the presence of smoke is software-driven from the fire protective alarm system central equipment. Provisions are incorporated at the central equipment to manually test and/or adjust the sensitivity of each smoke detector individually by means of a keyboard or keypad without requiring any replacement of equipment and/or "burning in" of firmware, and to print out a record thereof. The system also incorporates "alarm verification" features enabling a time-delayed re-check of any smoke detection signal prior to acknowledging a smoke alarm condition and acting thereon.
- F. Circuitry for the system complies with the following:
  - 1. Circuits are of the following types:
    - (a) Signaling line circuits (SLC's) are utilized for the transmission of multiple signals from outlying addressable initiating devices, addressable control modules and addressable monitoring modules.
    - (b) "Trunk" signaling line circuits are SLC's originating directly from the system head-end equipment.

- (c) "Branch" signaling line circuits are SLC's which are tapped off the "trunk" SLC's. Such circuits originate at outlying system equipment control cabinets, and are intended for the direct connection of outlying addressable initiating devices and/or modules.
- (d) Initiating device circuits (IDC's) are utilized for the connection of non-addressable devices (such as sprinkler water flow switches) to their associated addressable modules.
- (e) Notification appliance circuits (NAC's) are utilized for the connection of outlying alarm notification devices as follows:
  - (1) "Audible" NAC's are intended for the connection of loudspeakers.
  - (2) "Visual" NAC's are intended for the connection of strobes.

2. Trunk" SLC's comply with the following:

- (a) They are NFPA 72, Style 7 (Modified) incorporating isolators to limit the loss of signal transmission in the presence of wiring faults as describe hereinafter.
- (b) They originate at the system head-end equipment, and each consist of a Class "A" loop, the sending portion of which feed through outlying equipment control cabinets in which "branch" SLC's are tapped from the loop. The return portion of the loop is run directly - without intervening connections - back to the head-end equipment for termination.
- (c) The loop conductors are run in raceways (as specified hereinafter) throughout. The "sending" portion of the loops are physically separated from the "return" by a distance of not less than 50 feet (15 meters) except where they come together at the FACP, and each is 2-hour rated as hereinafter specified.
- (d) Within each outlying equipment control cabinet, and at the "sending" and "return" connections at the system head-end equipment, each loop incorporates isolators to sectionalize the loops. Two isolators per loop are provided in each outlying equipment control cabinet. They are so arranged that the wiring within the cabinet and the outgoing branch circuits can be completely isolated from upstream or downstream faults on the trunk loops.
- (e) The trunk SLC's - in conjunction with their associated isolators and head end equipment - function so as to provide bi-directional signal transmission enabling receipt of alarms and signals at the fire command station (FCS), and activation of addressable control modules from the FCS, in the event of a single open, a single ground, a wire-to-wire short or an open and a ground anywhere on the circuit. The only loss of transmission is for devices and/or modules connected to that portion of the loop (between isolators within the ECC) on which the wiring fault has occurred. Wiring faults on the loops, result in trouble signals at the FCS which identifies the location of the faults.

3. "Branch" SLC's comply with the following:
  - (a) They are NFPA72, Style 6, arranged to limit the loss of signal transmission as described hereinafter.
  - (b) They originate at outlying system equipment control cabinets (ECC's), and each consist of a Class "A" loop which is tapped from - and returns to - a "trunk" SLC, together with any transponders or other electronic components required to properly interface "trunk" and "branch" SLC's. Sending and return conductors are separated by a distance of not less than 20 feet (6 meters) except where they come together at ECC's, devices or modules.
  - (c) Where required for the accommodation of auxiliary control relays associated with outlying addressable control modules as described in later subsections, incorporate additional supervised power supply conductors originating at the ECC's.
  - (d) Include multiple "branch" SLC's within outlying system equipment control cabinets (ECC's) as required to insure that no more than 50 alarm initiating devices and/or addressable monitoring modules associated with non-addressable alarm or supervisory initiating devices are connected to a single "branch" SLC. Each "branch" SLC is tapped from a "trunk" SLC by means of isolators which will disconnect it from the "trunk" SLC in the event of a wire-to-wire short (and will initiate a trouble signal identifying the fault at the FCS) so as to allow the remaining "branch" SLC's originating within the same ECC to function normally.
  - (e) The loop conductors are run in raceways (as specified hereinafter)
  - (f) The "branch" SLC's function in conjunction with upstream circuitry and head-end equipment so as to provide bi-directional signal transmission enabling receipt of alarms and monitoring signals at the FCS, and activation of addressable control modules from the FCS, in the event of a single open, a single ground or an open and a ground on the circuit. Wiring faults on the circuits result in trouble signals at the FCS, identifying the faulted circuit.
4. Initiating device circuits (IDC's) comply with the following:
  - (a) They are NFPA72, Style B, so arranged in conjunction with field installed end-of-line devices as to be operational in the event of a single ground, and transmit trouble signals to the FCS via their associated monitoring modules (AMM's) in the event of an open or ground on the circuit. Such signals identify the AMM.
  - (b) Conductors for IDC's are installed in accordance with the requirements specified above for "branch" SLC's.
5. Notification appliance circuits (NAC's) comply with the following:

- (a) They are NFPA72 Style Y circuits, originating at the associated equipment control cabinets, and so arranged in conjunction with end-of-line devices as to permit audible or visual signal operation in the event of a single ground. Wiring faults cause receipt of trouble signals at the FCS identifying the faulted circuit.
  - (b) Conductors for NAC's are installed in accordance with the requirements specified above for "branch" SLC's, with the additional requirement that each is 2-hour rated as hereinafter specified until they enter the evacuation signaling zone that they serve. .
- 6. Circuits supplying outlying intercom stations (floor wardens stations) and outlying annunciators comply with the requirements specified hereinbefore for notification appliance circuits (NAC's).
- 7. Alternate circuitry and equipment arrangements which provide equal reliability (i.e., the ability to transmit and receive signals in the event of wiring faults) will be considered acceptable subject to proof of the reliability equivalence. In particular, systems employing dual communications buses will be considered if automatic transfer between buses without the loss of existing information - occurs in the event of a wiring fault or equipment failure associated with one bus.
- 8. Risers or trunk circuits supplying multiple floors are so arranged as to protect against the inability to initiate evacuation signals on more than one floor (or zone) in the event of fire on a single floor. To accomplish this, sending and return portions of loops or dual communications buses are so located as to be separated by a distance of not less than 50 feet (15 meters), and each is 2-hour rated as hereinafter specified.
- 9. Note that the use of "T-taps" or other such wiring techniques that limit the ability of addressable devices, addressable modules, loudspeaker, strobes or other devices to function normally in the event of wiring faults as described hereinbefore will not be allowed.
- 10. Provide the following as 2-hour rated cable or cable system except where enclosed within 2-hour rated construction as indicated on the architectural drawings:-
  - (a) Trunk signalling line circuits (Trunk SLC's).
  - (b) Notification appliance circuits (NAC's) until they enter the evacuation signaling zone that they serve.
- G. System equipment is of a type which insures that all signal and communication circuits are of the "power limited fire protective limited fire protective signaling type" as defined in Article 760 of the National Electrical Code.

- H. Outlying system equipment control cabinets (also referred to as equipment control cabinets or ECC's) are distributed throughout the project and incorporate all required circuit isolators, transponders, notification appliance addressable control and monitoring modules, power supplies, terminal strips and other equipment and wiring as required to provide all specified system features and functions. ECC's supplying multiple floors will be considered acceptable if they are contained, together with associated conductors in a two hour rated enclosure or space, and if they comply with the following:
1. Each floor supplied by an ECC is served by a separate "branch" SLC (or more than one if needed to comply with other criteria specified hereinafter), and such "branch" SLC(s) serve only that floor.
  2. A cabinet is provided on each floor, complete with interconnecting circuitry to the ECC from which it derives, to make available (at a similar location on each floor) terminals for the connecting of circuitry extensions to all devices (addressable initiating devices, addressable modules, loudspeakers, strobes, intercom stations, sub-system interfaces, and other items) which maybe required for the floor when it is fully occupied and fitted out. Terminals and interconnecting circuitry are as required to permit all system features and functions described within this Fire Protective Alarm System specification to be incorporated for each floor.
- I. ECC's are not located in electric closets. They are located in suitable 2-hour rated spaces as approved by the Engineer and/or where specifically shown on the drawings. Provide (coordinate with GC) 2-hour rated access panels where required. ECC's incorporate NEMA 1 enclosures, hinged lockable doors, electric supervision against unauthorized access and the removal of any components, and each have an attached engraved nameplate identifying the cabinet. If (as described hereinafter) distributed amplification for the fire evacuation public address system is optionally provided in lieu of the specified central amplification system, all required equipment is incorporated as part of the outlying ECC's - either in the same cabinets - or in separate supervised cabinets mounted adjacent thereto.
- J. Outlying addressable module boxes (or cabinets) are distributed throughout the project and contain addressable monitoring and/or control modules as follows:
1. An addressable monitoring module ("initiating device" type, i.e., AMM/ID) is provided adjacent to each sprinkler or standpipe waterflow device and each non-addressable alarm or supervisory initiating device.
  2. An addressable control module (ACM) is provided adjacent to each fan motor controller (or other device controller) for equipment whose operation must be automatically and/or manually controlled by the fire alarm system. Where two items are to be controlled at the same location, two such ACM units are provided.
  3. An addressable monitoring module ("status" type, i.e., AMM/S) is provided adjacent to each fan motor controller (or other device controller) for equipment whose operational status must be monitored by the Fire Alarm System. Where two status indications are to be monitored for equipment items (such as smoke purge dampers), two such AMM/S units are provided.
  4. Auxiliary relays are provided to comply with requirements specified hereinafter.

- K. System supervision of outlying circuitry and equipment incorporate the following:
1. Supervision against circuitry wiring faults as described hereinbefore.
  2. Supervision against unauthorized access and/or removal of components at ECC's as described hereinbefore.
  3. Supervision of addressable alarm initiating devices, addressable control or monitoring modules, and other outlying devices against removal, or - as described hereinbefore - against malfunction.
  4. Supervision of power supplies. Failure of any system power supply causes a trouble signal at the FCS identifying the affected power supply.
  5. Supervision of smoke detector/sensor device sensitivity so as to provide a "dirty head" notification at the FCS identifying the affected device.
  6. Supervision against loss of voltage at any system component requiring power for its proper operation. Such failure causes a trouble signal at the FCS identifying the location of the affected device(s).
  7. Supervision against "off-normal" manually initiated actions at the FCS. Any such action causes an identifying trouble signal at the FCS.
- L. Power supplies serving visual warning signals are of the regulated type having an output of 28 VDC (adjustable to 30 VDC)  $\pm 3$  percent.
- M. The system incorporates alarm (and other) operating features as follows:
- N. Reset of all alarm initiating device circuits, alarm notification circuits, and equipment control relays is accomplished from the fire command station. Manual fire alarm stations require local reset before central reset from the fire command station is possible. In no case will the above alarm reset procedure cause the re-setting of equipment control relays. Such devices require separate reset from the fire command station.
- O. It is possible to disconnect any floor, or any device or combination of devices on any floor, from the system to allow for maintenance, repairs, or the addition of system devices and wiring without disabling any other floor. Such disconnection causes a visual "disabled" annunciation at the fire command station identifying the floor and/or devices.
- P. Each manual station, smoke or heat detector, sprinkler/standpipe alarm or supervisory actuating device, and sub-system alarm or supervisory initiating device constitutes a separate zone for reporting to the fire command station. For display at the fire command station (FCS) and at outlying annunciator(s), each reporting zone (i.e., device) is individually identified, except that multiple smoke detectors (or multiple heat detectors) located within a single space may be identified by a common display. It is possible to separately identify and display the address of the individual detector(s) in alarm within any such space by means of an appropriate command at the FCS keyboard or keypad.

Q. The system provides for intercom and fire evacuation public address features as follows:-

1. The system is of a dual channel type, capable of automatically broadcasting alert tones followed by recorded announcements repetitively to all floors followed by evacuation tones. No tone signals is broadcast in stairwells.
2. Manual "on-off" control from the fire command station of evacuation tone signals, recorded announcements and flashing of strobes through loudspeaker stations on any or all floors. Manual deactivation of the loudspeaker evacuation tones from the fire command station does not deactivate flashing strobes.
3. Initiation of voice announcements from the fire command station through loudspeaker stations on any or all floors, and separately through loudspeaker stations in stairwells.
4. Intercom between fire command station and any floor warden station, such intercom being controlled from the fire command station. Call initiation from warden stations to fire command station is possible.
5. Intercom use does not interfere with simultaneous broadcasting of evacuation signals, alert tones or voice announcements over system loudspeakers.
6. Patching in of voice announcements from any floor warden station to the loudspeaker stations on any or all floors, such patching in being controlled from the fire command station.

R. The fire evacuation public address equipment in the system includes the following features and functions:

1. Amplifiers are sized to accommodate a quantity of speakers equal to that shown on the drawings, plus an additional bulk quantity of 10 speakers intended for installation at locations as directed throughout the system. Sizing is based on an average requirement of 2.0 watts per speaker.
2. Amplifiers have a frequency response range of  $\pm 1.5$  dB from 30 to 10,000 hertz and at rated output, less than 2 percent distortion over the frequency range of 60 to 15,000 hertz.
3. Failure of a power amplifier shuts down the amplifier and indicate a trouble condition. Amplifiers are arranged in such manner, either by pairing or automatic switchover, to provide redundancy.
4. Tone oscillators, microphone circuits and ancillary equipment are paired in a similar fashion to the amplifiers and be provided with either automatic or manual switchover to the redundant system.
5. Where the audio path consists of twisted pair "riser cables," it includes double the number of required pairs (as determined by the total number of speakers called for). Connections at the amplifiers are arranged to readily allow their "transfer" to future amplifiers as necessary.

- S. In lieu of the central amplification system described above, distributed amplification may be provided, however, such equipment conforms to the redundancy requirements described hereinbefore, and the outlying equipment must derive its power from the central equipment.
- T. Provide an outlying annunciator at each location shown on the drawings. Each outlying annunciator duplicates visually and audibly all "alarm," "trouble" and "supervisory" signals received at the fire command station. Each outlying annunciator also includes a master intercom station to duplicate all functions of the master intercom station at the fire command station. The annunciators are of the LCD type as utilized at the FCS. If local code authorities require other means of display, modify annunciator type so as to fully comply.
- U. Each floor warden station is semi-recessed. The station is painted Fire Department red and is clearly identifiable as to its function. It contains detailed operating instructions on a plate or label which is clearly visible when the station is opened. The body of the station contains: a telephone handset, call-in pushbutton or alternate call initiation method, indicator lamp, circuit electronics, and terminal strips. The handsets are red molded thermoplastic with stainless steel armored cord, and utilize commercial type transistor components. In rooms with fire pumps or fire water tanks, stations incorporate a long extension cord and take up reel for "remote" handset operation. Furnish a warden station for each elevator, and turn over to the elevator manufacturer for flush mounting in each cab.
- V. Whether indicated on the drawings, or not, a "rescue type" fire warden's station is provided in each "area of rescue assistance". Refer to the Architectural drawings for locations of such areas. "Rescue type" stations comply with the requirements for general floor warden's stations and additionally include a visual "call acknowledged" signal to indicate to hearing impaired persons that the call has been received at the fire command station. Include provisions at the fire command station to transmit an acknowledgment signal to "rescue type" fire warden's stations.
- W. Loudspeakers are wall mounted (or column mounted) as noted on the drawings. They are approved for "Fire Alarm Service," with an audio power rating of at least 2 watts and a frequency response of 400 to 4,000 Hz. They have a typical sound pressure rating of at least 90 dBA at 10 feet (3 meters) when measured in an anechoic chamber. Where greater sound pressure levels are required to insure audibility, speakers of higher wattage are utilized. In particular, 15 watt speakers are utilized in mechanical rooms where the ambient sound level exceeds 70 db. Loudspeakers comply with UL Standards applicable to loudspeakers for fire alarm use. The speaker is able to withstand 150 degrees F (55 degrees C) for three hours and still operate. The speaker is equipped with a multi-tapped matching transformer and a line supervision capacitor. The work of this section includes coordination of matching transformers and field settings of taps as required to insure code compliant audibility throughout. Each loudspeaker incorporates a visual warning signal (strobe) except as described hereinafter.
- X. Loudspeaker enclosures are in accordance with the following:
1. Each loudspeaker enclosure assembly except those in stairs incorporates an integral visual warning signal (strobe) as described hereinafter.
  2. Where indicated as being of the flush mounted type, they each consist of a round or square grille plate and flush mounting back box.



3. Where indicated as being of the surface mounted type, they each consist of an integral assembly of grille and enclosure, fully enclosing the speaker and matching transformer.
4. Where indicated as being of the bracket type, they each consist of an assembly of bracket mounting frame and speaker enclosure. Where two loudspeakers are shown in a back to back configuration, or where the speaker is called-out as bi-directional, the two speakers are incorporated into a single assembly.
5. Loudspeaker enclosures are finished in red.

Y. A visual fire warning device is incorporated as part of each loudspeaker assembly except as noted hereinbefore.

Visual fire warning devices are as follows:

1. They are suitable for synchronized operation at a flash rate of 1 to 1.1 flashes per second, and are of the self-synchronizing type or are suitable for use with synchronizing control units integral with the power supplies, or interpolated in the circuitry between power supplies and strobes (visual warning devices). Where not of the self-synchronized type, provide a sufficient quantity of synchronizing control units to fully utilize the installed power supply capacity for the project.
2. Each visual warning device consists of a U.L. approved xenon flash tube (strobe) with matching socket, integral factory mounted diode or other device (to permit the supervision of circuitry) and domed plastic lens to flash the word FIRE when activated. The strobes have a U.L. 1971 listed intensity of at least 75 candela. Where installed in corridors or in a room having no dimension greater than 20 feet (6 meters), a strobe having a U.L. 1971 listed intensity of 15 candela and a near-axis (i.e., non-polar distribution) intensity of at least 75 candela may be utilized.
3. Strobes are suitable for operation at a nominal voltage of 24 volts D.C. from power supplied by the system.
4. Strobes continue to flash until the system is reset.
5. If approved speaker/strobe units are not available in timely fashion, separately mounted strobe units may be provided, installed at adjacent locations as approved by the Architect. Under no circumstances are ceiling mounted strobe units be installed unless specific approval has been received in writing from the authorities having jurisdiction. Relocate any strobes indicated as ceiling mounted to locations approved by the Architect.

Z. Where separately mounted visual fire devices are indicated on the drawings, each device is of the type described above for the combined loudspeaker/strobe unit except that it is equipped with backbox and mounting plate intended for flush or surface wall mounting as directed. Unit is finished as directed.

- AA. Two or more loudspeaker circuits are provided to supply loudspeaker stations in each evacuation signaling zone. Loudspeakers in stairs are circuited separately from those on floors. Strobes are circuited as required, with no less than two circuits per evacuation signaling zone. Both speakers and strobes are connected to these circuits so that adjacent speakers are connected to different circuits, and similarly for strobes.
- BB. In addition to the loudspeakers shown on the drawings, provide a bulk quantity of loudspeakers (each with integral or adjacent strobe) complete with circuitry as required, and installed at locations as directed, throughout the project. Information does not exist at this time as to the proper locations at which these loudspeakers are to be installed. The system includes adequate capacity to accommodate these loudspeakers and strobes from adjacent outlying equipment cabinets, assuming an equal distribution among the system cabinets. The work of this section includes the responsibility for determining such locations based on tenant occupancy space planning drawings on a floor by floor basis as they are prepared by the Architect and/or interior designers or space planners. As noted hereinafter, this bulk quantity of loudspeakers is not to be included in the base bid quotation, but is to be included as part of a separate "breakout" quotation.
- CC. In addition to the loudspeakers described above, furnish one loudspeaker for each elevator cab, and turn over to the elevator manufacturer for flush recessed mounting in the cabs.
- DD. In addition to the loudspeakers described hereinbefore, provide one weatherproof loudspeaker/strobe at each exit on to each roof. The speakers are each complete with circuitry and are exterior mounted over or adjacent to the bulkhead door.
- EE. Each manual station is of the non-coded, electrically supervised type. The station is semi-flush, finished fire alarm red. The station is clearly labeled as to function and operation. The stations each include an integral addressable monitor module (AMM) to permit a separately identifiable signal to be transmitted to the fire command station via signaling line circuits as described hereinbefore. The station's "electronics" are mounted behind the body of the station, accessible by authorized personnel only. Alternately, the AMM may be separately mounted adjacent to the manual station and interconnected thereto, as described hereinafter. Manual stations located in unheated spaces have their associated AMM located in a nearby heated space as indicated or as directed by the architect.
- FF. Smoke detectors (also referred to as smoke sensors or sensor/detectors) are of the analog-addressable spot detector type. They are UL approved and installed in accordance with the manufacturers recommendations as to spacing and suitability for use in the specific application with consideration for the number of air changes per hour, ceiling height, ceiling profile, normal space environment (i.e., office space as compared to boiler rooms, etc.) and the type of risk. Detectors, for ceiling mounting in finished spaces, are of the semi-flush type. It is understood that semi-flush mounting requires the device to be suitable for application to a concealed outlet box.
- GG. Except as noted below, smoke detectors are of the ionization principle dual chamber type with UL approved field adjustable sensitivity features.
- HH. Smoke or heat detection devices indicated in kitchens and boiler rooms are of the 190 degrees F (88 degrees C) "fixed temperature only" type.

- II. Smoke detection devices in laboratories and maintenance shops and [garage areas are of the photoelectric cell type.
- JJ. Smoke detectors indicated in mechanical equipment rooms are of the combination photocell plus fixed temperature/rate-of-rise type.
- KK. Smoke detection devices have integrally mounted pilot lamps giving a "triggered" indication.
- LL. Smoke detection devices which are mounted in ducts or under raised floors or in ceiling plenums are supplied with remote "triggered" indication pilot wired in parallel, in an approved manner, with the similar pilots included integrally with detection units. The pilots for duct detectors are each flush or surface mounted within 15 feet (4.5 meters) circuiting distance of its associated detector. Mounting and location are as directed by the Architect. The pilots for detectors under raised floors or in ceiling plenums are remotely mounted in a graphic annunciator panel at a location within the computer space as directed.
- MM. Smoke detectors mounted in rooms with doors are each equipped with a remote "triggered" indication light wired in parallel with the pilot light integral with the detector. These remote pilot lights flush mounted in the corridor over or adjacent to the door to the room as directed by the Architect.
- NN. Smoke detectors indicated as being located in floor or ceiling cavities of the air handling type are equipped with "air shields" where air velocities are such as to require these appurtenances for the proper detection of smoke.
- OO. Heat detectors located in sprinklered elevator machine rooms or elevator shafts are of the 135 degrees F (57 degrees C) "fixed temperature only" type.
- PP. Duct smoke detectors are installed in accordance with the manufacturer's recommendations as to suitability for use in the specific application with consideration to air changes, size of duct and location within duct, and include sampling chambers and pick up tubes where required. Where installed within ducts and/or above ceilings in air plenums, the provision of access doors and mounting holes in such ducts and plenums will be separate from this work. The installation of the tubes and sampling chambers, however, is part of the work of this section. In addition, responsibility for supplying detailed drawings showing exact dimensional locations of sampling tubes, etc., in the plenums and ducts, as required for the optimum operation will be part of this work. Where duct configuration is such as to interfere with laminar air flow, special provisions are included as follows:
1. For unducted return systems, provide area type detectors, suitable for 500 feet per minute (150 meters per minute) air velocity, pipe mounted in the ceiling at the entry to the fan room. While every attempt has been made to properly define the required quantity of detectors (labeled "d"), at each such location, it is understood that detectors are provided on the following basis, regardless of the indicated quantities:

Duct width	Quantity of detectors
not more than 36 inches (91 cm)	1

Duct width	Quantity of detectors
greater than 36 inches (91 cm) but not more than 72 inches (182 cm)	2
greater than 72 inches (182 cm)	2 + (1) per each additional 24 inches (61 cm)

- QQ. Where combination photo-electric or ionization, plus heat, detectors are called for, separate units may be optionally substituted and their locations adjusted accordingly.
- RR. Control and monitoring of audible and visual alarm notification devices (loudspeakers and strobes) and associated circuitry is by means of addressable modules located in outlying system control cabinets.
- SS. Reporting of all required alarms and supervisory signals to the Fire Command Station (FCS) from initiating devices of the non-addressable type, including (but not limited to) sprinkler and standpipe waterflow and supervisory devices, manual fire alarm stations, sub-system (e.g., clean agent, pre-action sprinkler, etc.) alarm and supervisory contacts, and the like is accomplished in conjunction with addressable monitoring modules of the initiating device type (i.e., AMM/ID). AMM/ID's are of a type intended for connection of NFPA 72, Style 6 "branch" signaling line circuits (SLC) as described hereinbefore and are connected to the appropriate SLC on the floor on which they are located. Except where incorporated as part of manual fire alarm stations (or in the outlet boxes on which they are mounted), AMM/ID's are mounted adjacent to the associated initiating devices in outlying addressable monitor module boxes and are complete with engraved red nameplate. Each AMM/ID is interconnected to its associated initiating device by means of an initiating device circuit (IDC) as described hereinbefore. Provide an end-of-line resistor at each initiating device so as to permit supervision of the interconnecting circuitry. Terminals are incorporated in each addressable module box for the accommodation of all entering conductors.
- TT. Control (automatic and/or manual) and status reporting (monitoring) of equipment via the fire protective alarm system as specified hereinafter is accomplished by means of addressable control modules (ACM's) and addressable monitoring modules of the status reporting type (AMM/S's) located within 3 feet (1 meter) of the controlled equipment in outlying addressable monitor boxes similar to those specified above for the AMM/ID's. Addressable modules (ACM's and AMM/S's) are provided in accordance with the following:
1. ACM's and AMM/S's are of a type intended for connection to NFPA 72, Style 6 "branch signaling circuits (SLC's) as described hereinbefore, and are connected to the appropriate SLC serving the floor on which they are located.

2. Each ACM provides (2) SPDT contacts suitable for use at voltages up to 250 VAC and capable of interrupting 10 amperes inductive, and derives its operating and supervisory current at 24VDC from the SLC. If necessary, these contact ratings are accommodated by means of auxiliary control relays mounted within or adjacent to the same addressable monitor boxes as the ACM's, and deriving their operating power from the associated ACM's, or directly from the associated ECC via separate supervised power supply conductors.
  3. Each AMM/S functions so as to provide a readily identifiable status indication at the FCS in response to a 120 or 208 VAC signal from the associated controlled equipment. Incorporate an auxiliary status (monitoring) relay for each AMM/S to convert a 120 or 208 VAC AC signal to a "dry" contact if the AMM/S requires a "dry" contact for proper status signal initiation. Auxiliary status relays, if required, are mounted in the same outlying addressable module boxes as their associated AMM/S's.
  4. At locations where multiple equipment controllers are installed, the addressable modules (and any associated auxiliary relays) may be grouped in common addressable module boxes.
- UU. System operation is such as to provide automatic and/or manual control of fans larger than 2,000 CFM (56 cubic meters per minute), and of dampers and other equipment in response to alarm initiation, as well as central status reporting. Additionally, any fans over 2,000 CFM (56 cubic meters per minute) which are found not to require automatic control by the FPA system are provided with manual control (and status reporting) from FCS. Controls are provided in accordance with a schedule on the drawings and/or as described hereinafter. Include provisions at the FCS in outlying system equipment control cabinets, and in outlying addressable module boxes (or cabinets) - each located within 3 feet (1 meter) of the associated motor controller, smoke purge damper control device or other equipment control device, control circuitry extensions (i.e., final connections) from the addressable module boxes to the controlled equipment and connections, all as required to achieve this control.
- VV. Outlying addressable module boxes, each complete as indicated, are provided for equipment requiring automatic or manual control by the FPA system on the basis of the following:-
1. One box including two ACM's ("stop", "start") and one AMM/S ("running") for each fan over 2,000 CFM (56 cubic meters per minute) (including fans in self-contained air conditioning units).
  2. One box including two ACM's ("purge", "override purge") and two AMM/S's ("open"/"closed") for each smoke purge damper system. Refer to HVAC floor plans and risers for quantity of smoke purge damper systems (i.e., one system for each penetration of any multi-floor duct which will be used for smoke purge, and for each fan system which includes direct outside exhaust provisions).
  3. One addressable module box for each damper requiring individual manual control from the central damper control panel (specified hereinafter for normal after-hours control), but for which direct manual or automatic control by the fire alarm system is not specified. Include one ACM ("closed") and one AMM/S ("closed").

4. One addressable module box, including three ACM's ("recall", "recall to alternate floor", and "elevator not safe for use ") and one AMM/S ("elevators recalled") for each bank of elevators. Alternate floor recall: is initiated only in response to detector activation on the terminal floor. Elevator not safe for use: is initiated only in response to detector activation in associated elevator machine room or elevator shaft. Provide two additional ACM's ("de-energize/re-energize elevator power panel) for each bank of elevators if the elevator machine room and/or associated shaft is sprinklered. Also, include one AMM/S per bank ("panel de-energized").
  5. One addressable box, including one ACM for the fire stair door unlocking system.
  6. One addressable module box, including one ACM, for the fire/smoke door release system.
  7. One addressable module box, including one ACM for each fire stair or elevator machine room smoke vent.
  8. One addressable module box, including one ACM for each escalator controller.
  9. Additional addressable module boxes as necessary to comply with the scheduled control of equipment in response to system alarm actuating devices.
- WW. System operation includes manual over-ride control from -- and status reporting at -- the fire command station for each item of "controlled equipment" (such as fans, dampers, fire doors, elevators, etc.) which is to be automatically controlled in response to the operation of system alarm actuation devices as scheduled elsewhere, and for each smoke exhaust (purge) damper system and smoke purge fan. Re-start of fans shut down by an alarm is possible without clearing the alarm condition, (so as to assist in the smoke control) but only if a Fire Department key has been inserted in the Fire Command Station. Manual control of elevators will not be required, however, status reporting will be required on a per bank basis. Additional "manual only" control of certain fans and dampers (plus status) reporting) is provided if specified herein or scheduled on the drawings. To accomplish the aforementioned status reporting and manual control, include all required switching and status reporting devices at the Fire Command Station, and other necessary equipment at outlying equipment control cabinets and addressable module boxes, and all associated wiring, interwiring and final connections.
- XX. Provide interface circuitry for each damper requiring individual after hours control from the central damper control panel as described hereinafter, run from the fire command station to the central damper control panel. Provide relay contacts and other necessary components, and connect as required to establish "over-ride" open/close control of the dampers from the fire command station regardless of any actions occurring at the central damper control panel.

YY. The project contains multiple smoke exhaust (purge) systems, each requiring automatic purge initiation. Manual "purge" and "override purge" control will be required and is such as to require resetting at the fire command station for each attempt to "purge" or "override". Any re-attempts to "purge" or "override" subsequent to failure of dampers to operate requires manual resetting, as does the restoration of the fire alarm system to "normal" after an "alarm" condition. To accomplish smoke purge, include:

1. Manual switching and status reporting devices, automatic control devices and other necessary equipment and wiring, at the fire command station (FCS) to automatically or manually re-open, on a floor-by-floor (or zone-by-zone) basis, dampers which have been automatically closed in response to smoke (and which must be opened to permit purge) and to open normally closed smoke exhaust dampers. Where multiple damper systems require control for purge of a single floor or zone, they are controlled as a group.
2. Include damper "open"/"closed" group status indications for the purge dampers and separately for the isolation dampers on a floor by floor basis.
3. Equipment and wiring at the fire command station to automatically or manually start the smoke exhaust system motors and to indicate system status as well. Where multiple fans are required for purge of a single floor or zone they are controlled as group. Where the smoke exhaust shafts are normally used for other purposes (minimum outside air, return, etc.), the starting of the smoke exhaust fan system motors is preceded by the automatic shutdown of all other fans served by the shaft. Include equipment and wiring at the fire command station to accomplish this.
4. Addressable modules at outlying system equipment central cabinets and addressable module boxes and interconnecting circuitry and control circuit extensions, as required to accomplish the aforementioned operation of motors and dampers in conjunction with smoke purge, as described hereinbefore.

ZZ. Control of smoke exhaust system dampers has been specified hereinbefore on a system by system basis. For the purpose of quantifying the systems, it is understood that a separate system is required for:-

1. Each fan system including recirculating air systems, which includes provisions for exhaust directly to the outside.
2. For each fan used for smoke exhaust, include three (3) additional damper systems.

Refer to HVAC air flow riser diagrams, control diagrams and/or floor plans for information as to the required smoke exhaust dampers. Refer to "Smoke Exhaust System Wiring Diagram" for detailed information regarding wiring arrangement. "No cost" modifications to this wiring arrangement will be considered for approval.

AAA. Include in the central equipment the means of controlling damper operation so as to allow smoke purge operation at any floor or combination thereof for all control fan systems.

- BBB. Manual control of supply and return floor isolation dampers on each floor will be required for normal building after-hours operation from a central damper control panel (CDCP), utilizing fire protective alarm system central equipment, outlying equipment control cabinets and circuitry as described hereinbefore. Additionally, these dampers will require manual override from the fire command station (FCS) and automatic control of dampers for smoke control as described below and/or specified hereinbefore. Note that the automatic control sequences and the manual control from the FCS overrides the CDCP control. To accomplish this control, include as part of the fire alarm system:
- CCC. The central damper control panel (CDCP) consists of a code gauge sheet steel housing incorporating an open/close control switch and status pilot light for all dampers on each floor requiring individual floor manual control. It also includes all encoder transponders, power modules, equipment control and status reporting relays and ancillary devices as required for the proper operation of the dampers via the aforementioned tie to the fire command station as follows:
1. Open/close control and status reporting for each floor group of dampers. Control is so arranged that it will be overridden by fire alarm system automatic operation or by manual operation from the fire command station.
  2. The central damper control panel is located adjacent to the Central Mechanical Panel as directed.
  3. Addressable modules (and other necessary items) at the outlying cabinets and addressable boxes, control circuit extensions and interconnecting circuitry as specified hereinbefore, and/or as otherwise needed to provide the specified control functions.
- DDD. For each central multifloor system supply fan whose return ductwork will be used for smoke purge provide (at the fire command station), equipment and wiring as required to automatically close all supply and return dampers on the floors served by the system, in response to alarm initiation, and to make available a control source (via a system "master" E.P. or process control device) for selectable floor by floor damper operation for smoke control. Provide a control module in the appropriate equipment control cabinet and control circuit extension to the "master" device. Modules for the individual dampers have been specified before.
- EEE. At the fire command station, include devices to provide status reporting of the emergency generator ("running," "off") and each automatic transfer switch "normal," "emergency") plus manual control thereof. In addition, include an (8) wire control circuit extension from the fire command station to the emergency generator and each transfer switch and connect as required for status reporting and manual control. Include auxiliary relays if required.
- FFF. At the fire command station, include devices to provide time delayed (adjustable 0-180 seconds) automatic "de-energize control" of each elevator power panel in response to EMR or elevator shaft heat detector operation, plus status indication and manual re-energize control therefrom.
- GGG. Provide all system equipment and circuitry as required to provide supervisory indications at the fire command station in response to operation of fire suppression equipment contacts (furnished by others) as follows:
1. The fire pump.



- (a) "Pump running".
    - (b) "Failure of Power."
  - 2. Each water tank used for fire fighting purposes.
    - (a) "Low Water Level".
    - (b) "High Water Level".
  - 3. Refer to sprinkler and/or plumbing drawings for location of fire pumps and water tanks.
- HHH. The fire command station (i.e., the display and control section of the central equipment which requires operator interface) includes all components necessary for the system to function as specified, and incorporates a custom built display panel arranged to match the main lobby decor as directed by the Architect. The display panel is arranged to enable a minimum of four (4) simultaneous alarms to be displayed and include an overflow indicator and alarm advance feature. The display panel incorporates a back illuminated flashing fire sign module with 3 inch (76 mm) high red letters. Components of the central equipment which do not require operator interface are mounted in racks or cabinets. If space conditions so require such equipment is remotely located within 50 feet (15 meters) of the fire command station in a nearby, unfinished, ventilated space (as directed by the Architect). All required interconnections are included and are run in conduit.
- III. Overall system supervision is accomplished by means of the response to continuous interrogating signals transmitted from the central equipment. The signal transmission rate is such that an "alarm" or "trouble" signal is processed and displayed within the 10 second maximum response time specified hereinbefore, and that subsequent initiation of automatic actions (fan shutdown, e.g.) is similarly initiated within 10 seconds.
- JJJ. LCD displays and keyboards are "user friendly" incorporating the following features:
- 1. English language display.
  - 2. Visually displayed prompts for access to "help screens," "system status files," etc.
  - 3. Keyboard includes special function keys whose functions are clearly evident, e.g., "purge," "pressure," "start," "stop," "open," "close," "status," "fans," "damper," "help."
- KKK. System software is such that the use of the aforementioned special function keys enable commands to be carried out with minimum effort. For example, purging of the 4th floor is accomplished by typing "4" followed by depressing the "purge" key. This either initiates all required control functions or displays any further action required for the purge.

- LLL. In lieu of the special function keys and associated software as described above, system software may be of a type which permits direct "English language" keyboard entries (without the need for look-up tables) as required for the manual control of fans and dampers for smoke purge and other smoke control functions.
- MMM. System display is prioritized so as to display alarms, controlled equipment status, supervisory indications and system test reports in a sequence and format as approved by the architect and by all authorities having jurisdiction. Specifically:
1. Equipment status display is derived from addressable monitoring modules controlled by limit switches or auxiliary contacts as indicated elsewhere.
  2. Equipment status and/or changes in equipment status is not automatically displayed except that changes in status of equipment may be automatically displayed if they result from a fire alarm initiation event.
  3. Where the status of equipment controlled by alarm initiation is not automatically displayed, the manual steps necessary to provide this display appear on the LCD along with the alarms.
- NNN. Display formats which employ mnemonic codes and/or which depend upon written text material in order to properly operate the system are not considered as meeting these specifications.
- OOO. The provisions for manual control and status reporting required at the Fire Command Station to comply with the specification requirements expressed hereinbefore, in addition to the LCD and keyboard control and status features, consist of maintained contact selector switches and pilot lights, assembled complete with engraved nameplates, into a readily accessible panel section of the Fire Command Station. Include all required equipment, devices and circuitry as necessary to interface with the central equipment of the system. Status is continuously displayed, and manual control of motors, dampers and other devices is possible without resorting to the use of the keyboard and/or keypad associated with the LCD display. Lamp test provisions is incorporated for the pilot lights. If this panel section cannot be accommodated within the confines of the enclosure allocated for the Fire Command Station, then it is separately wall (or other) mounted at an adjacent location approved by the Architect and the authorities having jurisdiction, and all required interwiring is included.
- PPP. The fire command station includes a graphic annunciator panel in addition to the LDC display specified hereinbefore. The panel displays:
1. Each fire reporting zone (at least one zone per floor) an LED (or other) status indication for each of the reporting device types (i.e., manual station area smoke detector, duct smoke detector, heat detector, waterflow device, subsystem alarm).
  2. All fans and the areas served by each, with a status LED for each.
  3. All smoke purge or pressurization dampers with a status LED for each.
- The panel display complies in all respects with Fire/Building Department requirements regarding size, format, construction and display.

- QQQ. Provide detailed dimensional shop drawings of the fire command station to the party responsible for providing the enclosure. It is understood that the installation of the fire command station equipment within such enclosure is part of this work.
- RRR. Include at the Fire Command Station (FCS) a Fire Department approved key switch which must be operated in order to permit manual initiation of smoke purge and any other smoke control sequences, including the re-start of equipment shut down by a system alarm prior to the clearing of the alarm condition. This key is in addition to the basic required means of securing the entire FCS against tampering by unauthorized personnel.
- SSS. As part of this work, each outlying component requiring a power supply for its proper operation receives this supply over wires extended from the central equipment in a code approved manner. Power supply circuitry is 2-hour rated cable or cable system except where enclosed within 2-hour rated construction as indicated on the architectural drawings.
- TTT. The system includes the following features associated with the analog addressable smoke detectors (sensors):
1. An independent "alarm verification" feature for each individual smoke detector. In response to activation of a detector, the system does not go into alarm until the detector has been reset, and has gone into alarm once again. A suitable, adjustable, time delay is incorporated into the reset procedure. Provisions are incorporated to bypass this alarm verification feature for any or all detectors so as to comply with Fire Department requirements.
  2. An independent "maintenance alert" feature for each individual detector, providing a notification at the FCS identifying any detector which is operating at or above a pre-determined adjustable percentage of its alarm threshold.
  3. An independent "sensitivity adjustment" feature for each individual detector, allowing the adjustment to be made from the FCS.
  4. An independent "test" feature for each individual detector, allowing detector operation to be checked from - and its sensitivity reported at - the FCS.
  5. A "status report" feature which provides status reports and detector sensitivity reports for each individual detector. Status reports include a summary of any initiating devices (smoke detectors or other) which have been manually disabled by operator action. Such reports are printed out in response to a command from the FCS.
- UUU. The central equipment is supplied with an emergency power unit including batteries and battery charging equipment which maintains this cabinet and all outlying equipment that it subfeeds operational without any change in status for a minimum period of twenty-four (24) hours. The emergency power unit is sized to meet the following minimum requirements: operating in normal (supervisory) mode, twenty-four (24) hours, followed by 4 hours of emergency operation, except that voice alarm signaling need operate for only (15) minutes at maximum connected load. Increase if necessary to conform to additional requirements imposed by code enforcement agency. Optionally, emergency power to supply outlying equipment may be provided by local battery and charger units contained within the equipment. Battery low voltage alarm contacts activates "trouble" indication at the central

equipment. Batteries are of the sealed maintenance free type.

VVV. The central equipment and outlying equipment cabinets incorporate power supply provisions capable of accommodating strobes (either individually mounted or incorporated integrally with loudspeakers) on the basis of the indicated quantity of strobes, including any strobes specified in bulk, plus 50 percent spare. Risers are sized to accommodate an "all call" arrangement for strobe operation. Emergency power for the strobes is provided by means of batteries and chargers located in the outlying equipment cabinets, and sized for 5 minutes of continuous operation after 24 hours of supervision. Batteries are of the sealed maintenance free type.

WWW. The system includes a station for manually activating the relay (called for elsewhere) at the central equipment intended for transmission of an alarm signal and to put the building fire protective alarm system into alarm. This station is located at the telephone switchboard (or at a location as specifically directed in the field) and includes all required circuitry.

XXX. Central equipment, signal transmission facilities and outlying control cabinets has capacity to handle spare points (which are in addition to those required for all functions hereinbefore specified and/or indicated in the drawings) in accordance with the following criteria:

1. "Trunk" and "branch" signaling line circuits (SLC's) are capable of accommodating enough spare alarm or supervisory initiating device points and spare equipment control points for future growth. Each equipment control point is understood to consist of two independent control functions plus two independent monitoring (i.e., "status") functions.
2. System equipment control cabinets accommodate trunk and branch circuits adequate for the required active points plus the spare points and devices specified above, and power supplies contained therein are adequate for these quantities.
3. The central equipment has capacity for the spare points described above, plus an additional capacity equal to 25 percent of those described above. The central equipment contains all equipment and devices necessary to activate these spare points. Any software necessary to support these points is also be included.

YYY. The system incorporates a "fail safe" control feature accounting for a lack of response to a fire alarm indication at the fire command station. The feature incorporates an "acknowledge" button on the fire command station, which if not depressed (following the appearance of a fire alarm indication) within a preset time period as stipulated by the Fire Department, will cause the evacuation tone signal to be sounded through all loudspeaker stations on the system.

ZZZ. The system is equipped with a "hard copy" printer located at the Fire Command Station or at another location as directed by the Architect. It incorporates the following features:-

1. It duplicates all alarm supervisory and trouble signals automatically generated by the system or operator action.
2. Changes in the status of fans, dampers and other equipment are not printed unless the change was automatically generated by an alarm initiation.

3. Print format is of alpha-numeric character which includes the month, day, year and time of occurrence, and the type and location of alarm, supervisory and trouble conditions which exist. Alarm, supervisory and trouble data are portrayed in English or mnemonic code which is readily identifiable (as approved by the Architect).
4. It prints out status and sensitivity reports for the analogue addressable smoke sensors automatically generated by the system or by the operator. It also prints out on command a listing of any indicating devices which have been "disabled" by the system operator.
5. It includes a carriage which accepts standard (6 inch (150 mm) minimum width) roll or fan fold paper with tractor feed.
6. It operates at a print speed of a minimum of 30 characters per second and have a print density of 10 characters per inch (4 characters per cm).

AAAA. The printer is supplied with paper feed features (bails, baskets and the like) and a suitable printer stand.

BBBB. Physical features of the Fire Protective Alarm System complies with the following:-

1. Components indicated on the drawings are located where shown. Components which are required for proper operation, but which are not indicated on the drawings are located in mechanical or electrical rooms, at accessible locations within suspended ceilings or at locations for which express permission of the Architect has been obtained.
2. The visual aspect of all components of the system which are exposed to view is acceptable to the Architect.
3. Consoles are for desk or wall mounting or for setting into an architectural wall, cabinet or table as directed by the Architect.

CCCC. Unauthorized access to operable components at the Fire Command Station is prevented by means of lockable hinged doors on panels.

DDDD. Operating instructions are provided within the FCS or mounted beyond glass in a frame adjacent thereto.

EEEE. For the Central Station Service, provide a 3/4 inch (DN 21) empty rigid conduit from the Fire Command Station to the telephone frame room. Also provide a 2 #12 THWN in 3/4 inch (DN 21) conduit run from a 20 amp fuse cutout in the Fire Signaling System cutout panel to the telephone frame room. Terminate both runs as directed.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Submit a separate "breakout" price quotation for the bulk quantity of loudspeakers (with integral strobes) specified hereinbefore. As noted hereinbefore, this price is not to be included in the total base bid price, and is intended only to identify the bulk quantity cost should the Owner choose to exercise the option either partially or totally. This cost includes furnishing, installation and circuitry as described hereinbefore. The unit price quotation requested below is equal to the "breakout" price divided by the bulk quantity.
- B. Submit separate unit price for each of the items listed below. Each unit price quotation is for complete work, furnished, installed, complete with pro-rata interconnecting circuitry as required for its proper operation. Equipment, materials and installation methods are same as for base bid. Quotations are suitable for both additions and deductions. Unit price quotations are required for:
- |                   |  |
|-------------------|--|
| Item No. <u>1</u> | Loudspeaker (with integral strobe unit)                |
| Item No. <u>2</u> | Manual fire alarm station                              |
| Item No. <u>3</u> | Smoke detector for flush or surface mounting           |
| Item No. <u>4</u> | Smoke detector (with sampling tubes) for duct mounting |
| Item No. <u>5</u> | Wardens intercom station                               |
| Item No. <u>6</u> | Individually mounted strobe unit                       |
- C. Include as part of the base bid quotation the cleaning and sensitivity adjustment of smoke detectors and sampling tubes as needed during the warrantee period and the periodic regular testing of system devices to comply with Building Department and Fire Department requirements, during the warrantee period.
- D. In addition to the base bid price quotation, submit separate quotations for each of the "Service Contract" components described hereinafter. It is understood that these quotations are for a one (1) year period commencing with the expiration of the warrantee period. The "contract" is renewable, at the Owner's option, for one (1) year periods up to a total of five (5) years. The renewal contracts are based on the original, escalated by the national C.P.I. index. The quotations are for the following:
1. Inspection and Test - Provide all material and labor to test system by actuating all outlying alarm initiating devices, all manual control devices at the fire command station and annunciators, as well as verifying operation of all loudspeakers/strobes and wardens stations. Adjust as required to provide optimum system performance. Cleaning and adjusting of smoke detectors is excluded. Parts and labor for repairs and/or replacements is also excluded. Provide unit prices for all components of the system, installed in place. This service is provided at regular intervals complying with the requirements of the Building Department and the Fire Department.
  2. Cleaning and Adjusting Smoke Detectors - Provide all material and labor for cleaning and adjusting the sensitivity of all area and duct type smoke detectors and sampling tubes. Cleaning is performed every six months.

The sensitivity is checked once per year, and adjusted as required to insure compliance with UL requirements. Where detectors cannot be adjusted to so comply, they are replaced. Quotations are on a per unit basis for the cleaning and adjusting, with a separate quotation for replacement of any head that cannot be field adjusted to be within UL specified limits.

3. Repairs and Replacement - Provide all labor and parts as necessary to repair and/or replace any and all defective equipment components.
- E. If the fire alarm system is not manufactured locally, but is supplied by a local distributor, the manufacturer will provide a "letter of support" stipulating that when - in the opinion of the engineer - the distributors efforts require backup, the manufacturer will provide at no cost to the Owner, all required technical support manpower in a timely manner during the installation period, and for a one year two year warrantee period thereafter.
- F. The fire alarm system manufacturer stipulates to the following:
1. Upon acceptance of the system, the manufacturer, or his factory authorized distributor will turn over to the Owner the job-specific program information (on disk) to enable the servicing, repair and expansion of the system by any factory-approved service agency the Owner opts to utilize.
  2. Prior to award of contract, the manufacturer will furnish the names of (3) factory approved service agencies located within 50 miles of the project. Such agencies are capable of providing all levels of maintenance servicing and programming as may be required. Failure to comply will be sufficient grounds for disqualifying the system manufacturer.

### 3.2 INSTALLATION, GENERAL

- A. Install system according to NFPA standards referred to in Parts 1 and 2 of this Section.
- B. Each outlying component requiring a power supply for its proper operation receives this supply over wires extended from the central equipment in a code approved manner.
- C. Comply with the applicable requirements of other sections of Division 16 for locating and routing circuitry, for installing circuitry, for firestopping and for identification.
- D. Adjust the sensitivity of all smoke detector (sensors) on the basis of the actual environment to which each will be subjected (i.e., air movement, ambient dust/dirt levels and temperature, humidity levels) in accordance with manufacturers instructions.
- E. Paint the outside parts of all equipment cabinets and all junction boxes, pull boxes and outlet boxes red.

### 3.3 EQUIPMENT INSTALLATION

- A. Manual Pull Stations: Mount semiflush in recessed back boxes with top of operating handles 48 inches (122 cm) above the finished floor or lower as indicated.
- B. Water-Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised.

- C. Smoke Detectors: Install ceiling-mounted detectors not less than 4 inches (10 cm) from a side wall to the near edge. Install detectors located on the wall at least 4 inches (10 cm), but not more than 12 inches (30 cm) below the ceiling. For exposed solid-joist construction, mount detectors on the bottom of the joists. On smooth ceilings, install detectors not over 30 feet (9 meters) apart in any direction. Install detectors no closer than 60 inches (150 cm) from air registers.
- D. Loudspeaker/Strobes: Install 80 inches (203 cm) (to bottom of device) above the finished floor nor less than 6 inches (15 cm) below the ceiling. Install on flush-mounted back boxes with the device-operating mechanism concealed behind a grille or as indicated. Provide box extension and furnish collar where wall depth cannot accommodate flush backbox. Combine audible and visual alarms at the same location into a single unit.
- E. Control Panels: Surface mount with tops of cabinets not more than 72 inches (182 cm) above the finished floor. Conduits are not permitted to enter the top of control cabinets. Only side and bottom entries are permitted.
- F. Provide final connections (i.e., control circuit extensions) from each addressable module box to the equipment "controller" it services, utilizing THWN wires run in conduit in accordance with the following:-
1. From each box supplying a fan motor, provide a 5 #14 control circuit run in conduit to the motor controller and connect as indicated on the drawings.
  2. From each box supplying a supply or return damper which must be closed by the FPA system to isolate a floor served by multi-floor fan system which will be allowed to run during a fire, provide a 5 #14 THWN run in conduit to the damper control device and end switch. Provide, for each box, a 120 volt supply from a normal panel. Connect for damper closure and status indication in response to automatic alarm initiation on the floor or manual control from the Fire Command Station. Provide a 2 #14 in conduit circuitry run to an interface control device (relay or other) for each damper. Device will be provided within 10 feet (3 meters) of the damper as part of the automatic temperature control work. Connect as directed.
  3. From each box supplying a damper requiring individual manual control from the central damper control panel (CDCP), but for which direct manual or automatic control by the FPA system is not specified, provide a 5 #14 run in conduit to the damper control device and end switch. Provide, for each box, a 120 volt supply from a "normal" panel. Connect for damper closure and status indication in response to manual control from the CDCP. Provide a 2 #14 in conduit circuitry run to an interface control device (relay or other) for each damper. Device will be provided within 10 feet (3 meters) of the damper as part of the automatic temperature control work. Connect as directed.
  4. From each box supplying elevators, provide a 8 #14 run in conduit to the elevator group controller, and connect so that elevators are recalled to the terminal floor - or alternate floor - in response to operation of waterflow switch, elevator lobby detector, or elevator room smoke or heat detector, an "elevators recalled" status signal is activated at the FPA system central equipment, and an "elevators not safe for use" signal is activated in the elevators in response to operation of detectors in the elevator machine room or elevator shaft. If the elevator machine room and/or associated shafts are



sprinklered, provide an additional 6#14 run in conduit from the box to an upstream device, arranged so as to provide a time delayed (adjustable 0 - 180 seconds) shutdown of the power to the elevator power panel, to permit a remote manual restoration of power from the FCS, and a "status" indication at the FCS.

5. From the box supplying the fire stair door unlocking system, provide a 2 #12 run in conduit to an adequate 120 volt supply and a 2 #12 extension in conduit to all fire stair door unlocking mechanisms. Provide any necessary low voltage supplies, and connect so that all doors are unlocked in response to the operation of any automatic alarm initiating device on the system or in response to all "elevators recalled" status signal generated by these automatic devices or by operation of the Firemen's Service key for Phase I recall. Include a 3 #12 run in conduit to a switch and pilot light station located adjacent to the FCS and manual unlocking.
6. From the box supplying the fire/smoke door release system, provide a 2 #12 run in conduit to an adequate 120 volt supply and a 2 #12 extension in conduit to all fire/smoke door release mechanisms. Provide door release mechanisms and any required low voltage power supplies, and connect so that all doors are released in response to the operation of any automatic alarm initiating device on the system. Include a 3 #12 run in conduit to a switch and pilot light station and connect for manual door release.
7. From each box supplying a fire stair or elevator machine room smoke vent, a 4 #12 run in conduit to the smoke vent release mechanism and limit switch. Include a release in response to a local smoke detector and status indication.
8. From each box supplying an escalator controller, a 4 #14 run in conduit to the controller and connect for shutdown and status indication in response to operation of any waterflow switch or smoke detector on the system.

### 3.4 WIRING INSTALLATION

- A. Wiring Method: Install wiring in metal raceway in accordance with the following. Conceal raceway except in unfinished spaces and as indicated. Note that certain circuitry has been specified hereinbefore as 2-hour rated. These requirements are in addition to the requirements that follow.
  1. Cable is run in conduit throughout, and conforms to the requirements for nonpower-limited fire protective signaling circuit cable as expressed in Article 760 of the National Electrical Code, and is U.L. classified to conform to these requirements. For conductors #14 AWG and larger, cable insulation types THHN, THHW or XHHW is considered as fulfilling these requirements. Smaller size conductors have insulation types specifically U.L. approved as type NPLF, and so identified by markings on the outer surface of the cable at regular intervals. Conduit is electric metallic tubing or threaded metallic conduit subject to the restrictions hereinbefore specified for light and power circuitry throughout the project.
- B. Minimum conductor size for circuitry supplying loudspeakers or strobes is #16 AWG copper and for all other circuitry not specifically sized elsewhere minimum conductor size is #18 AWG copper.

- C. Wiring within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the 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, pressure-type terminal blocks, or plug connectors.
- D. Conduits are not permitted to enter the top of control cabinets. Only side and bottom entries are permitted.
- E. Cable Taps: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- F. 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-notification circuits differently from alarm-initiating circuits. Use different colors for visual alarm-notification circuits. Paint fire alarm system junction boxes and covers red.

### 3.5 GROUNDING

- A. Ground cable shields and equipment according to system manufacturer's instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.
- B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.
- C. Connect to grounding electrode specified in Division 16 Section "Grounding and Bonding." Install grounding electrode conductors of type, size, location, and quantity as indicated. Comply with installation requirements of Division 16 Section "Grounding and Bonding."
- D. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.

### 3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
- B. Include the services of an independent certified testing agency acceptable to the local fire department, where so required by the fire department or local regulations, for pretesting and final testing. Include costs to perform testing outside of normal working hours if required by fire department or by project schedule.

- C. Pretesting: After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
- D. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.
- E. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.
- F. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72. Minimum required tests are as follows:
  - 1. Verify the absence of unwanted voltages between circuit conductors and ground.
  - 2. Test all conductors for short circuits using an insulation-testing device.
  - 3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.
  - 4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
  - 5. Test initiating and notification circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and notification devices. Observe proper signal transmission according to class of wiring used.
  - 6. Test each initiating and notification device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
  - 7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.
  - 8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.
- G. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
- H. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests.

- I. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

### 3.7 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.
- B. Adjusting: Adjust sensitivity of each detector based on the environment to which it will be subjected.

### 3.8 DEMONSTRATION

- A. Startup Services: Engage a factory-authorized service representative to provide startup service and to demonstrate and train Owner's maintenance personnel as specified below.
  - 1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of 16 hours training.
  - 2. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
  - 3. Schedule training with Owner with at least 7 days advance notice.

### 3.9 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to 3 requested adjustment visits to the site for this purpose.

END OF SECTION 16721

**NEW PASSENGER TERMINAL  
DULUTH INTERNATIONAL AIRPORT  
DULUTH, MINNESOTA**

**SECTION 16741 - TELECOMMUNICATIONS  
DISTRIBUTION SYSTEMS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes telecommunications distribution systems, including a provision for service by the telephone utility organization.
- B. Related Sections: The following Division 16 Sections contain requirements that relate to this Section:
  - 1. "Raceways and Boxes" for telecommunications raceways, including conduit, tubing, wireways, and surface raceways.
  - 2. "Basic Electrical Materials, and Methods."
  - 3. "Electric Identification."

**1.3 SUBMITTALS**

- A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for system components.

**1.4 QUALITY ASSURANCE**

- A. Comply with NFPA 70.
- B. Provide materials that are Underwriters Laboratories listed and labeled.
  - 1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
- C. Coordination of Work: Coordinate the Work of this Section with the requirements of the Owner's telecommunications system suppliers and of the telephone utility organization.
  - 1. Meet jointly with the representatives of the above organization and the Owner's representative to exchange information and agree on details of installation interfaces.

## PART 2 - PRODUCTS

## 2.1 FACILITIES FOR ACCOMMODATION OF TELECOMMUNICATIONS WIRE AND DEVICES

- A. Outlets for telecommunications wiring shall conform to the specifications for standard convenience receptacle outlets, except that they are to be without wiring devices and shall have:-
1. Raised single gang cover (where flush wall mounted) and blank plate. For wall telephone units, include provision for support of unit.
  2. For each stanchion type floor outlet -- a stanchion with a bushed hole plate and capacity to handle telecommunications wiring and devices. Where supplied from circuitry run concealed in the ceiling below, each stanchion shall be of the "dual service" type, integrated with an approved fire-rated through-floor fitting capable of accommodating 120 volt and telecommunications wiring and devices.
  3. For each flush type floor outlet [which does not occur integrally within the preset inserts of the specialty cast-in-floor raceway systems] -- a 3" high by 1" I.P.S. standpipe with proper adapter for a flush floor outlet.
- B. Raceways: Comply with Division 16 Section "Raceways and Boxes."
- C. Except where specifically indicated otherwise, raceway for telecommunications wiring shall be:-
1. For main runs                      Electric Metallic Tubing
  2. For branch runs                      Electric Metallic Tubing  
to outlets                                  and/or Surface Metal Raceway
- all raceway materials being subject to the same limitations in usage as hereinbefore specified.
- D. Exclude EMT where located within 8'-0" of the floor in mechanical spaces (or otherwise exposed to mechanical damage), or intended for embedment in concrete.
- E. Boxes and Cabinets: Comply with Division 16 Section "Cabinets, Boxes, and Fittings."
- F. Telecommunications cabinets shall consist of code gauge galvanized sheet metal cabinets, complete with interior plywood backboards, and flush, inset covers, and prepunched knock-outs on the top, bottom and sides.
- G. Backboard: 3/4-inch (19 mm) interior grade plywood. Where installed in wire closet, height and width must cover entire wall up to 8 feet (2.5 m) above floor, except as otherwise indicated.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Telephone Service: Comply with telephone utility organization requirements as to details of the telephone service.
- B. Distribution System: Install completely so system will be fully operational when telephone instruments and switching equipment are connected.
- C. Comply with applicable requirements for locating and routing circuitry, for installing circuitry, and for fire-stopping as described in other sub-section of Section 16050.
- D. Raceway: Install telecommunications service and distribution raceway where indicated as specified in Division 16 Section "Raceways and Boxes."
- E. No more than two (2) 90° bends (or the equivalent thereof) in conduit for telecommunications wiring will be permitted between junction boxes, pull boxes, cabinets or other cable access points. Radius of bends in all runs other than branch runs to outlets shall be 48" minimum.
- F. Wall Outlets: Install blank covers only on devices which are not to be wired at this time under another Contract. Turn over blank covers to the Owner.

### 3.2 RACEWAY INSTALLATION

- A. Outlets for telecommunications wiring are to be circuited up with "empty conduit circuitry" in accordance with the following:-
  - (a) For one outlet -- 3/4"
  - (b) For two outlets -- 3/4"
  - (c) For first of three outlets -- home run only or to outlet ahead -1"
  - (d) or first of four outlets -- home run only -1-1/4"
- B. At any location where empty conduit telecommunications outlet circuitry is extended from a flush mounted telecommunications cabinet to a suspended ceiling immediately above, at least four 1-inch empty conduits shall be included (in addition to those required for present outlets) to permit future connections from the cabinet. The empty conduits shall extend up from the panel and shall terminate in a threaded conduit cap immediately after turning out into the hung ceiling space.
- C. All conduits provided for telecommunications wiring terminate in approved bushings.
- D. All empty conduit, circuitry or raceways for telecommunications wiring shall be provided with a minimum of nylon drag cords secured at each end.

### 3.3 GROUNDING

- A. Install ground terminal at service location and connect in accordance with Division 16 Section "Grounding and Bonding."

### 3.4 IDENTIFICATION

- A. Identify telecommunications system backboards and cabinets with the legend "Telecommunications." Perform all identification in accordance with Division 16 Section "Electrical Identification."
- B. All junction boxes for telecommunications wiring shall be clearly identified as to their function (e.g., tel, data).

### 3.5 CLEANING AND PROTECTION

- A. Prior to final acceptance, clean system components and protect from damage and deterioration.

END OF SECTION 16741



**NEW PASSENGER TERMINAL  
DULUTH INTERNATIONAL AIRPORT  
DULUTH, MINNESOTA**

**SECTION 16801  
ADMINISTRATIVE WORKSTATIONS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes: Administrative workstations.

**1.3 SUBMITTALS**

- A. Product Data: Provide manufacturer's complete data sheet for each type of product indicated.

**1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: Submit manufacturer's data sheet and original software disks provided with computer.

**1.5 QUALITY ASSURANCE**

- A. Installer Qualifications: Manufacturer and Microsoft certified technician.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a NRTL, and marked for intended location and application.
- C. Comply with NFPA 70.

**1.6 COORDINATION**

- A. Coordinate installation and setup of workstations with administrative staff and network installation.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Dell Computer
  2. Lenovo Computer
  3. Toshiba Computer

### 2.2 HARDWARE DESCRIPTION

- A. Desktop Workstation
1. The workstations shall be Windows 7-certified computers.
  2. At a minimum, each client workstation shall include the following:
    - a. Intel Core i5 2400 Processor (3.1 GHz)
    - b. 4GB DDR3 non-ECC 1333 MHz Dual Channel SDRAM
    - c. Integrated Intel HD Graphics Video
    - d. 250GB 7200 rpm 3.5" SATA hard drive (6Gb/s with 8MB Cache)
    - e. Ethernet network interface card (10/100/1000)
    - f. Keyboard, mouse
    - g. 20-inch LED flat panel monitor
    - h. 16X DL DVD + / - RW, optical drive
    - i. 4 USB 2.0 Ports, 2 USB 3.0 Ports
    - j. High efficiency power supply
    - k. Small or Ultra Small Form Factor Chassis
- B. Laptop Workstation
1. The workstations shall be Windows 7-certified computers.
  2. At a minimum, each client workstation shall include the following:
    - a. Intel Core i5 2410M Processor (2.3 GHz)
    - b. 6GB DDR3 non-ECC 1333 MHz Dual Channel SDRAM
    - c. Integrated Intel HD Graphics Video
    - d. 250GB 7200 rpm 3.5" SATA hard drive (6Gb/s with 8MB Cache)
    - e. Ethernet network interface card (10/100/1000)
    - f. 8X DL DVD + / - RW, optical drive
    - g. 3 USB 3.0 Ports, 1 eSATA/USB 2.0 Combo, 1 external VGA monitor, 1 IEEE 1394a, and 1 DisplayPort
    - h. Integrated sound with stereo speakers
    - i. Integrated 2MP webcam
    - j. 802.11 a/b/g/n wireless
    - k. 6-cell (55W-Hr) Li-ion battery
    - l. Energy Star rated
- C. Accessories
1. Desktop Workstation
    - a. Stereo speaker system
  2. Laptop Workstation

- a. Laptop carrying case
- b. USB travel mouse

## 2.3 SOFTWARE DESCRIPTION

- A. Operating System
  - 1. Microsoft Windows 7 Professional with XP mode
- B. Productivity Software
  - 1. Microsoft Office 2010 Professional
  - 2. Roxio Creator
  - 3. Cyberlink PowerDVD

## 2.4 WARRANTY

- A. Four year basic warranty service with four year next-business-day limited on-site service.

END OF SECTION 16801

