

SECTION 16A  
ELECTRICAL WORK, INTERIOR  
PART 1 - GENERAL

1. APPLICABLE PUBLICATIONS: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 Federal Specifications (Fed. Spec.):

J-C-30A and Am-1	Cable and Wire, Electrical (Power, Fixed Installation)
L-C-530B and Am-1 and Int Am-2	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
L-P-387A and Am-1 and Int Am-2	Plastic Sheet, Laminated, Thermosetting (For Designation Plates)
L-P-1035A	Plastic Molding Material, Vinyl Chloride Polymer and Vinyl Chloride-Vinyl Acetate Copolymer, Rigid
W-B-30A and Am-2	Ballast, Fluorescent Lamp (Non-Polychlorinated Biphenyl Type)
W-C-375B/GEN	Circuit Breakers, Molded Case; Branch Circuit and Service (General Specification)
W-C-586C	Conduit Outlet Boxes, Bodies, and Entrance Caps, Electrical: Cast Metal
W-C-596F/GEN and Suppl 1	Connector, Electrical, Power, General Specification for
W-F-406C	Fittings for Cable, Power, Electrical and Conduit, Metal, Flexible
W-F-408D	Fittings for Conduit, Metal, Rigid (Thick-Wall and Thin-Wall (EMT) Type)
W-F-1234A	Fixture, Lighting (Fluorescent Lamp Industrial)
W-J-800 E	Junction Box; Extension, Junction Box; Cover, Junction Box (Steel, Cadmium, or Zinc-Coated)

W-L-00116D	Lamps, Fluorescent (General Specification)
W-L-142a and Am-2 and Int Am-4	Lampholder, Adapter, and Shadeholder, Medium-Screw-Shell, 125, 250, and 600 Volts
W-P-115B	Panel, Power Distribution
W-P-455A and Am-6	Plate, Wall, Electrical
W-S-610C and Am-1	Splice, Conductor
W-S-865C and Am-1 and Int Am-2	Switch, Box, (Enclosed), Surface-Mounted
HH-I-553C and Am-1	Insulation Tape, Electrical (Rubber, Natural and Synthetic)
HH-I-595C	Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic
WW-C-581E	Conduit, Metal, Rigid, and Intermediate; and Coupling, Elbow, and Nipple Electrical Conduit: Steel Zinc Coated
American Society for Testing and Materials (ASTM) Publication:	
D 69-78	Friction Tape for General Use for Electrical Purposes
Institute of Electrical and Electronics Engineers (IEEE) Standard:	
No. 142-1982	Recommended Practice for Grounding of Industrial and Commercial Power Systems
National Electrical Manufacturers Association (NEMA) Standards:	
LA 1-1976 (R 1980)	Surge Arrestors
RN 1-1980	Polyvinyl-Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing
SG 3-1982	Low-Voltage Power Circuit Breakers
National Fire Protection Association (NFPA) Publication:	
No. 70-1984	National Electrical Code

## 1.6 Underwriters Laboratories, Inc. (UL) Publications:

### Building Materials Directory (Jan 1983 with Quarterly Supplements)

UL 5	Surface Metal Raceways and Fittings (Dec 28, 1979, 9th Ed.; Rev Feb 25, 1982)
UL 20	General-Use Snap Switches (Dec 28, 1979, 9th Ed.; Rev thru May 10, 1984)
UL 50	Cabinets and Boxes (Apr 25, 1980, 8th Ed.; Rev thru Feb 11, 1982)
UL 57	Electric Lighting Fixtures (Aug 30, 1972, 12th Ed.; Erratum Sep 23, 1975; Rev thru Jul 22, 1982)
UL 467	Grounding and Bonding Equipment (Nov 22, 1984, 6th Ed.; Rev Nov 23, 1984)
UL 514	Outlet Boxes and Fittings (May 14, 1979, 6th Ed.; Rev thru Jun 1, 1982)
UL 844	Electric Lighting Fixtures for Use in Hazardous Locations (Oct 24, 1978, 8th Ed.; Rev thru Oct 10, 1983)
UL 943	Ground-Fault Circuit Interrupters (Dec 11, 1972, 1st Ed.; Rev thru Dec 2, 1977)

## 2. GENERAL:

2.1 Rules: Unless otherwise specified, the installation shall conform to the requirements of NFPA No. 70.

2.2 Coordination: The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment will be properly located and readily accessible. Lighting fixtures, outlets, and other equipment and materials shall be located to avoid interference with mechanical or structural features; otherwise, lighting fixtures shall be symmetrically located according to the room arrangement. Raceways, junction boxes, and lighting fixtures shall be supported from metal arch as indicated. If any conflicts occur necessitating departures from the drawings, details of departures and reasons therefor shall be submitted as soon as practicable for written approval of the Contracting Officer.

2.3 Hazardous Locations: Wiring in locations indicated shall conform to the NFPA No. 70 for Class I and II, Division 1 and 2, hazardous locations. Equipment shall be suitable for Groups C and D.

2.4 Standard Products: Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the

product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.5 Identification Nameplates: Panelboards shall be permanently identified by specific unit number as indicated. Identification nameplates shall be made of laminated plastic conforming to Fed. Spec. L-P-387 with black outer layers and a white core. Edges shall be chamfered. Lettering shall be 1/4 inch high. Plates shall be fastened with black-finished round-head drive screws. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic.

3. APPROVAL OF MATERIALS AND EQUIPMENT: Materials and equipment will be approved based on the manufacturer's published data.

3.1 Underwriters Laboratories, Inc., (UL) Publications: The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, the Contractor shall submit a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer.

3.2 Non-Underwriters Laboratories, Inc., (UL) Publication: For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable Federal Specification, Military Specification, or standard of the American Society for Testing and Materials, National Electrical Manufacturers, or other commercial standards, is acceptable.

3.3 Shop Drawings; Shop drawings shall be submitted for equipment not completely identifiable by information submitted in the materials and equipment lists, in accordance with requirements contained in the SPECIAL CLAUSES, and will be submitted for, but not limited to, panelboards.

## PART 2 - PRODUCTS AND EXECUTION

4. WORKMANSHIP: Materials and equipment shall be installed in accordance with recommendations of the manufacturer to conform with the contract documents. The installation shall be accomplished by workmen skilled in this type of work.

5. MATERIALS AND EQUIPMENT: Materials and equipment shall conform to the respective publications and other requirements specified below. Other materials and equipment shall be as specified elsewhere herein and as shown on the drawings.

5.1 Fluorescent Lamp Ballast: High-power-factor type conforming to Fed. Spec. W-B-30. In addition, ballasts for 34 watt and larger lamps shall be Class P and shall be automatic-resetting type.

5.2 Cables: Cables shall conform to Fed. Spec. J-C-30 and shall be of annealed copper. Cables shall be single-conductor type, unless otherwise indicated. Grounding cables shall be bare or shall have green low-voltage insulation.

5.3 Circuit Breakers: Molded-Case and Insulated-Case Circuit Breakers: Fed. Spec. W-C-375.

Conduit:

5.4.1 Zinc-Coated Rigid Steel Conduit: Fed. Spec. WW-C-581.

5.4.2 Conduit Coatings:

5.4.2.1 Plastic Resin System: Fed. Spec. L-C-530, Type I; or L-P-1035, composition, type, class, and grade suitable for the purpose, thickness as required for the Type I system of Fed. Spec. L-C-530; or NEMA RN 1, Type A-40.

5.4.2.2 Epoxy System: Fed. Spec. L-C-530, Type II.

Connectors, Wire Pressure: Fed. Spec. W-S-610.

Device Plates: Fed. Spec. W-P-455.

5.7 Fittings, Cable and Conduit: Fed. Spec. W-F-406 and W-F-408.

Fixtures:

5.8.1 Fluorescent, Industrial-Type Fixtures: Fed. Spec. W-F-1234 modified as required for circuits specified.

5.8.2 Fluorescent, General-Purpose Fixtures: Fed. Spec. W-F-414, Type II, style A, B, C and D, and W-F-1662.

5.8.3 Incandescent Lighting Fixtures: UL 57.

5.8.4 Hazardous Location Fixtures: UL 844.

Lamps:

5.9.1 Fluorescent Lamps: Fed. Spec. W-L-116.

5.9.2 Incandescent Lamps, Large: Fed. Spec. W-L-101.

5.10 Outlets: Conduit, Cast-Metal or Malleable Metal: Fed. Spec. W-C-586.

5.11 Panelboards: Dead-front construction, Fed. Spec. W-P-115. Lighting and appliance power feeder, and distribution panelboards, Class 1, type as specified hereinafter.

5.12 Receptacles: Fed. Spec. W-C-596, except that receptacles with groundfault interrupters shall conform to UL 943, Class A or B.

5.13 Sockets, Medium-Screw Base: Fed. Spec. W-L-142.

Splice, Conductor: Fed. Spec. W-S-610.

Switches: Snap Switches: UL 20.

Tapes:

5.16.1 Plastic Tape: Fed. Spec. HH-I-595.

5.16.2 Rubber Tape: Fed. Spec. HH-I-553.

5.17 Grounding and Bonding: UL 467. Ground rods shall be of copper-clad steel not less than 3/4-inch in diameter, 10 feet long, driven full length.

6. GROUNDING: Except where specifically indicated otherwise, all exposed noncurrent carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic raceways and neutral conductor of the wiring system shall be grounded. The ground connection shall be made by others at the main service equipment and shall be extended by others to the panelboard ground bus. Generally all supplemental grounding electrodes shall be ground rods. Ground connections shall be made to driven rods on the exterior of the building. The maximum resistance measured in accordance with IEEE No. 142 of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, drive two additional rods not less than 10 feet on centers, or if sectional type rods are used, two additional sections may be coupled and driven with the first rod. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately.

## 7. WIRING METHODS:

7.1 General Requirements: Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid zinc-coated steel conduit, Type I.

7.2 Conduit Systems: Conduit systems shall be installed as indicated. Conduit sizes shown are based on the use of TW insulation for conductors smaller than No. 8 AWG, except where otherwise indicated. Minimum size of raceways shall be 1/2-inch. Raceways crossing structural expansion joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding. Wiring installed in underfloor raceway system shall be suitable for installation in wet locations.

7.2.1 Installing Conductors and Conduit Below Slab-on-Grade or in the Ground: All electrical wiring below slab-on-grade shall be protected by a conduit system. No conduit system shall be installed horizontally within concrete slabs-on-grade. For slab-on-grade construction, horizontal runs of rigid steel shall be installed below the floor slab. Conduit passing vertically through slabs-on-grade shall be rigid steel. Rigid steel conduits installed below slab-on-grade or in the earth shall be field-wrapped with 0.010-inch thick pipe-wrapping plastic tape applied with a 50-percent overlay, or shall have factory-applied plastic resin or epoxy coating system. Zinc coating may be omitted from rigid steel conduit which has a factory-applied epoxy system.

7.2.2 Exposed Raceways: Exposed raceway shall be installed parallel or perpendicular to walls, structural members or intersections of vertical planes and ceilings.

7.2.3 Changes in Direction of Runs: Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Care shall be taken to prevent the lodgment of concrete, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be entirely freed of obstructions or shall be replaced.

7.2.4 Supports: Raceway shall be securely and rigidly fastened in place at intervals of not more than 10 feet with approved pipe straps, wall brackets, conduit clamps, conduit hangers or threaded C-clamps with retainers unless otherwise shown. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structures. Fastenings shall be by expansion bolts on concrete or brick; by machine screws or welded threaded studs on steel work. Threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Holes cut to a depth of more than 1-1/2 inch in reinforced concrete beams or to a depth of more than 3/4-inch in concrete joists shall avoid cutting the main reinforcing bars. Holes not used shall be filled. Conduits shall be fastened to all metal boxes and cabinets with two locknuts where required by the NFPA No. 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Bushings shall be installed on the ends of all conduits and shall be of the insulating type where required by the NFPA No. 70. A pull wire shall be inserted in each empty raceway in which wiring is to be installed by others if the raceway is more than 50 feet in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 150 feet in length. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 200-pound tensile strength. Not less than 10 inches of slack shall be left at each end of the pull wire.

7.3 Conductors: Conductors in raceways shall be of copper. Wire connectors of insulating material or solderless pressure connectors properly

taped shall be utilized for all splices where possible. Soldered mechanical joints insulated with tape shall be kept to a minimum.

7.3.1 Sizes shall not be less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long from panel to load center, shall be No. 10 AWG.

7.3.2 Conductor insulation shall be suitable for the application and shall have a temperature rating of not less than 75 degrees Celsius except sizes smaller than No. 1/0 AWG may be 60 degrees Celsius.

7.3.4 Conductor identification of each phase shall be by color-coded insulation. The color of the insulation of the ungrounded conductors of different voltage systems shall be as follows:

120/240 volt, single/phase: red and black.

Circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, or equivalent means as approved by the Contracting Officer. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking is not acceptable.

8. BOXES AND SUPPORTS: Boxes shall be provided in the wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be of the cast-metal threaded hub type when located in normally wet locations, when surface mounted on outside of exterior surfaces, when located in hazardous areas, and when installed exposed up to 7 feet above interior floors. Boxes for mounting lighting fixtures shall be not less than 4-inches square except that smaller boxes may be installed as required by fixture configuration, as approved. Unless otherwise indicated, boxes for wall switches shall be mounted 48 inches above finished floors. Cast-metal boxes installed in wet locations shall be gasketed. Separate boxes shall be provided for flush fixtures when required by the fixture terminal operating temperature. Boxes and supports shall be fastened with bolts and metal expansion shields on concrete or brick, and with machine screws or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts may be used in lieu of expansion shields, or machine screws. In open overhead spaces, cast-metal boxes threaded to raceways shall be supported as shown on the drawings. Cast-metal boxes with 3/32-inch wall thickness are acceptable. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4-inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel.

8.1 Boxes for Use with Raceway Systems: Boxes for use with raceway systems shall not be less than 1-1/2 inches deep except where shallower boxes required by structural conditions are approved. Boxes for other than lighting-fixture outlets shall be not less than 4 inches square except that 4- by 2-inch boxes may be used where only one raceway enters the outlet.

8.2 Pull Boxes: Pull boxes of not less than the minimum size required by the NFPA No. 70 shall be constructed of cast-metal. Boxes shall be furnished with gasketed screw-fastened cast-metal covers. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation.

9. DEVICE PLATES: One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be of cast-metal having rounded or beveled edges. Screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Plates shall be installed with all four edges in continuous contact with the cast-metal box. Plates shall be installed with an alignment tolerance of 1/16-inch. The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed.

#### 10. RECEPTACLES:

10.1 Duplex Receptacles: Duplex receptacles shall be two-pole, three-wire grounding type with ground-fault interruption provisions and polarized parallel slots. The ampere and voltage rating shall be suitable for the maximum ampere demand calculated and the voltage rating of the service available at the specific igloo or magazine. Generally, the receptacles shall be rated not less than 20 amperes at 125 volts alternating current and rated to trip when any ground-fault current exceeds 20 milliamperes. Bodies shall be of molded brown phenolic compound supported by a metal mounting strap. Contact arrangement shall be such that metal-to-metal contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per terminal.

10.2 Weatherproof Receptacles: Weatherproof receptacles shown shall be mounted in a box with a gasketed, weatherproof, cast-metal cover plate and cap over each receptacle opening. The cap shall be provided with a spring-hinged flap.

11. WALL SWITCHES: Switches shall be of the totally enclosed tumbler type with bodies of phenolic compound. Handles shall be brown. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than one switch shall be installed in a single-gang position. Switches shall be rated 20-ampere, 120/277-volt for use on alternating current only. Pilot lights indicated shall consist of yoke-mounted candelabra-base sockets rated at 75 watts, 125 volts, and fitted with glass or plastic jewels. A clear 6-watt lamp shall be furnished and installed in each pilot switch. Jewels for use with switches shall be red.

12. SERVICE EQUIPMENT: Service-disconnecting means shall be located in the lighting panelboard and be of the enclosed molded-case circuit breaker type as indicated with external handle for manual operation. The panelboard assembly shall be listed as suitable for service entrance equipment. Enclosures shall be sheet metal with hinged cover for surface mounting unless otherwise indicated.

13. **PANELBOARDS:** Lighting and appliance branch circuit panelboards shall be circuit-breaker equipped, Type I, Class 1 of Fed. Spec. W-P-115. Panelboards shall not exceed 78 inches in height and shall be so mounted that the height of the top operating handle will not exceed 6 feet 6 inches from the floor. Locks shall be keyed alike. Nameplates shall be as approved. Directories shall be typed to indicate load served by each circuit and mounted in holder behind a protective covering.

14. **UNDERGROUND-SERVICE CONDUITS:** Empty conduits for underground electric-service cable shall be installed as indicated. Except where otherwise indicated, conduits shall terminate approximately 5 feet beyond the building wall and 2 feet below finished grade, with the outside ends capped.

15. **LAMPS AND LIGHTING FIXTURES:**

15.1 **Lamps:** Lamps of the proper type, wattage, and voltage rating shall be delivered to the project in the original cartons and installed in the fixtures just prior to the completion of the project.

5.1.1 Incandescent lamps shall be for 120-volt operation unless otherwise indicated.

5.1.2 The 9-watt fluorescent lamps shall have standard cool-white color characteristics and shall be of a type that will not require starter switches. Lamps shall be of the rapid-start type.

15.2 **Fixtures:** Fixtures shall be as shown on the drawings or shall conform to the following specifications and shall be as detailed on Drawing No. 40-06-04, Sheet No. 61, which accompany and form a part of this specification. Illustrations shown on these sheets are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs and equivalent energy efficiency, light-distribution and brightness characteristics, and of equal finish and quality will be acceptable if approved. Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.

16. **PAINTING AND FINISHING:** Field-applied paint on exposed surfaces shall be provided under SECTION: PAINTING, GENERAL.

17. **REPAIR OF EXISTING WORK:** The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be carefully done, and any damage to roadways, building, or equipment shall be repaired by skilled mechanics of the trades involved, at no additional cost to the Government.

18. **TESTS:** After the interior-wiring-system installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated

to operate in accordance with the requirements of this specification. The test shall be performed in the presence of the Contracting Officer. The Contractor shall furnish all instruments and personnel required for the tests, and the Government will furnish the necessary electric power. The Contractor shall submit in writing to the Contracting Officer upon completion of the project the measured ground resistance of each ground rod, indicating the location of the rod and the resistance and the soil conditions at the time the measurements were made.