PLAINTIFF'S EXHIBIT
E-24

JIM PUSEY

National Electrical Contractors Association

To: All NECA members, our customers and industry allies

Since the founding of our organization in 1901, the National Electrical Contractors Association had been quick to participate in those industry programs aimed at the development of rules for the practical safeguarding of the American Public--our customers. The National Electrical Code, sponsored by the National Fire Protection Association, and approved by the American National Standards Institute, is a product of these programs. Members of NECA represent electrical contractors on the Correlating Committee and the Code Making Panels of the NFPA National Electrical Code Committee which is responsible for the development of this Code.

NECA members believe that because of their particular knowledge gained from everyday experience with electrical installations, they have a responsibility to the public to participate in the formulation of this Code. They also recommend that it be adopted by local governmental bodies and properly enforced by those exercising legal jurisdiction over electrical installations as the minimum requirements necessary in the interest of the public.

To further the promulgation the National Electrical Code, NECA, through the cooperation of NFPA, designed this distinctive cover and had it attached to the regular printing of the Code by NFPA. Additional copies are available from NECA.

Robert W. Colgan
President

Kernan B. Dennis
Chairman
Codes and Standards Committee

September 1, 1977

National Electrical Code
1978 Edition

NFPA No. 70-1978

1978 Edition of National Electrical Code

This 1978 Edition of the National Electrical Code (NFPA No. 70-1978) was adopted by the National Fire Protection Association at its Annual Meeting held May 16-19, 1977 in Washington, D.C. It has been submitted to the American National Standard Institute for approval by that organization and when and if approved, the approval date will be included in the following printings and it will be known as NFPA 70-1978 (ANSI). It supersedes all previous editions of the National Electrical Code, the most recent previous edition being 1975.

Changes in this 1978 Edition of the National Electrical Code (as compared with the 1975 Edition) are indicated by vertical lines in the margin.

This Code is purely advisory as far as the NFPA and ANSI are concerned but is offered for use in law and for regulatory purposes in the interest of life and property protection (see copyright statement on Page 70-ii). Anyone noticing any errors should please notify the NFPA Executive Office, the Chairman and the Secretary of the Committee.

Development of National Electrical Code

Consistent with the Rules of Procedure for the National Electrical Code Committee a "PREPRINT" OF THE PROPOSED AMENDMENTS FOR THE 1978 NATIONAL ELECTRICAL CODE was published by the National Fire Protection Association in July 1976. This "PREPRINT" recorded the actions of the various Code-Making Panels and the Correlating Committee of the National Electrical Code Committee on each proposal that had been made to revise the 1975 Code. Subsequently, the various Code-Making Panels finalized their recommendations and their reports were processed through the Correlating Committee of the National Electrical Code Committee. This was preparatory to the formal presentation of this 1978 Edition of the National Electrical Code in EC-TCR of the 1977 NFPA TECHNICAL COMMITTEE REPORTS. This latter publication was circulated to all members of the National Electrical Code Committee, to other interested NFPA members, and offered to the public through technical releases in the interested trade papers. The action of the 1977 NFPA Annual Meeting as to the adoption of the 1978 Edition is recorded in the PROCEEDINGS of that Meeting published by the Association in the September 1977 issue of *Fire Journal*.

Coincident with the above processing procedures, each of the Code-Making Panels and the Chairman of the Correlating Committee reported their recommendations to meetings of the Electrical Section at both the 1976 and 1977 NFPA Annual Meetings. The Electrical Section thus had opportunity to discuss and review the report of the National Electrical Code Committee prior to the adoption of this Edition of the Code by the Association.

SC-ELEC-07100

(b) Temporary electrical power and lighting installations shall be permitted for a period not to exceed 90 days for Christmas decorative lighting, carnivals, and similar purposes, and for experimental or development work.

305-2. General.

(a) Services. Services shall be installed in conformance with Article 230.

(b) Feeders. Feeders shall be protected as provided in Article 240. They shall originate in an approved distribution center. The conductors shall be permitted within multiconductor cord or cable assemblies or where not subject to mechanical injury, they shall be permitted to be run as open conductors on insulators not more than 10 feet apart.

(c) Branch Circuits. All branch circuits shall originate in an approved power outlet or panelboard. Conductors shall be permitted within multiconductor cord or cable assemblies or as open conductors. All conductors shall be protected by overcurrent devices at their rated ampacity. When run as open conductors they shall be fastened at ceiling height every 10 feet. No conductor shall be laid on the floor. Each branch circuit that supplies receptacles or fixed equipment shall contain a separate equipment grounding conductor when run as open conductors.

(d) Receptacles. All receptacles shall be of the grounding-type. Unless installed in a complete metallic raceway all branch circuits shall contain a separate equipment grounding conductor and all receptacles shall be electrically connected to the grounding conductor.

See Section 210-8 for receptacles installed on construction sites.

(e) Earth Returns. No bare conductors nor earth returns shall be used for the wiring of any temporary circuit.

(f) Disconnecting Means. Suitable disconnecting switches or plug connectors shall be installed to permit the disconnection of all ungrounded conductors of each temporary circuit.

(g) Lamp Protection. All lamps for general illumination shall be protected from accidental contact or breakage. Protection shall be provided by elevation of at least 7 feet from normal working surface or by a suitable fixture or lampholder with a guard.

(h) Splices. On construction sites a box shall not be required for splices or junction connections where the circuit conductors are multiconductor cord or cable assemblies or open conductors. See Sections 110-14(b) and 400-9. A box shall be used wherever a change is made to a raceway system or a cable system which is metal clad or metal sheathed.

(i) Flexible cords and cables shall be protected from accidental damage. Sharp corners and projections shall be avoided. When passing through doorways or other pinch points, protection shall be provided to avoid damage.

305-3. Grounding. All grounding shall conform with Article 250.

B. Over 600 Volts, Nominal

305-10. Use. Temporary wiring over 600 volts shall be permitted during periods of construction, tests, experiments, or emergency. A less permanent class of wiring and equipment shall be permitted than would be required for permanent installations.

305-11. Guarding. Suitable fencing, barriers, or other effective means shall be provided to prevent access of other than authorized and qualified personnel to temporary wiring.

305-12. Temporary wiring over 600 volts shall be removed immediately upon completion of construction or purpose for which the wiring was installed.

305-13. Grounding of Equipment. Equipment shall be grounded in accordance with Section 250-42.

ARTICLE 310 – CONDUCTORS FOR GENERAL WIRING

A. General

310-1. Scope. This article covers general requirements for conductors and their type designations, insulations, markings, mechanical strengths, ampacity ratings, and uses. These requirements do not apply to conductors that form an integral part of equipment, such as motors, motor controllers, and similar equipment, or to conductors specifically provided for elsewhere in this Code.

For flexible cords and cables, see Article 400. For fixture wires, see Article 402.

310-2. Conductors to Be Insulated. Conductors shall be insulated.

Exception: Where covered or bare conductors are specifically permitted elsewhere in this Code.

See Section 250-152 for insulation of neutral conductors of a solidly grounded high-voltage system.

310-3. Stranded Conductors. Where installed in raceways, conductors of size No. 8 and larger shall be stranded.

Exception No. 1: When used as busbars or in mineral-insulated metal-sheathed cable.

Exception No. 2: Bonding conductors as required in Sections 680-20(b)(1) and 680-22(b).

310-4. Conductors In Parallel. Aluminum, copper-clad aluminum, or copper conductors of size 1/0 and larger, comprising each phase or neutral, shall be permitted to be connected in parallel (electrically joined at both ends to form a single conductor) only if all of the following conditions are met: All of the parallel conductors shall be of the same length, of the same conductor material, same circular mil area, same insulation type and terminated in the same manner. Where run in separate raceways of cables, the raceways or cables shall have the same physical characteristics.

Exception: As permitted in Section 620-12(a)(1) Exception.

When metallic equipment grounding conductors are used with conductors in parallel, they shall comply with the requirements of this section except that they shall be sized as per Section 250-95.

When conductors are used in parallel, space in enclosures shall be given consideration (see Articles 370 and 373). Conductors installed in parallel

shall be subject to ampacity reduction factors as required in Note 8 to Tables 310-16 through 310-19.

310-5. Minimum Size of Conductors. Whether solid or stranded, conductors shall not be smaller than No. 14 copper or No. 12 aluminum or copper-clad aluminum.

Exception No. 1: For flexible cords as permitted by Section 400-12.

Exception No. 2: For fixture wire as permitted by Section 410-23.

Exception No. 3: For fractional hp motors as permitted by Section 430-22.

Exception No. 4: For cranes and hoists as permitted by Section 610-14.

Exception No. 5: For elevator control and signaling circuits as permitted by Section 620-12.

Exception No. 6: For Class 1, Class 2 and Class 3 circuits as permitted by Sections 725-16, 725-37, and 725-40.

Exception No. 7: For fire protective signaling circuits as permitted by Sections 760-16, 760-27, and 760-30.

310-6. Underground Conductors. Cables of one or more conductors for direct burial in the earth or in underground raceways shall be of a type approved for the purpose and use.

Where necessary to prevent physical damage to the conductors from rocks, slate, or similar materials, or from vehicular or similar traffic, direct buried conductors shall be provided with supplementary protection, such as sand, sand and suitable running boards, suitable sleeves, or other approved means.

See Section 339-3 for Type UF cable.

310-7. Wet Locations.

(a) Insulated Conductors. Insulated conductors used in wet locations shall be (1) lead-covered; (2) Types RHW, RUW, TW, THW, THWN, XHHW; or (3) of a type approved for the purpose.

(b) Cables. Cables of one or more conductors used in wet locations shall be of a type approved for the purpose and use.

Such conductors shall not be used for direct burial in the earth unless of a type approved for the purpose.

310-8. Corrosive Conditions. Conductors exposed to oils, greases, vapors, gases, fumes, liquids, or other substances having a deleterious effect upon the conductor or insulation shall be of a type approved for the purpose.

310-9. Temperature Limitation of Conductors. No conductor shall be used in such a manner that its operating temperature will exceed that designated for the type of insulated conductor involved. In no case shall conductors be associated together in such a way with respect to type of circuit, the wiring method employed, or the number of conductors that the limiting temperature of any conductor is exceeded.

310-10. Conductor Identification.

(a) Grounded Conductors. Insulated conductors of No. 6 or smaller, intended for use as grounded conductors of circuits, shall have an outer identification of a white or natural gray color. Multiconductor flat cable

No. 4 or larger shall be permitted to employ an external ridge on the grounded conductor.

Exception No. 1: Multiconductor varnished-cloth-insulated cables.

Exception No. 2: Fixture wires as outlined in Article 402.

Exception No. 3: Mineral-insulated metal-sheathed cable.

Exception No. 4: A conductor identified as required by Section 210-5(a) for branch circuits.

Exception No. 5: Where the conditions of maintenance and supervision assure that only qualified persons will service the installation, grounded conductors in multiconductor cables shall be permitted to be permanently identified at their terminations at the time of installation by a distinctive white marking or other equally effective means.

For aerial cable the identification shall be as above, or by means of a ridge so located on the exterior of the cable as to identify it.

Wires having their outer covering finished to show a white or natural gray color but having colored tracer threads in the braid, identifying the source of manufacture, shall be considered as meeting the provisions of this section.

For identification requirements for conductors larger than No. 6, see Section 200-6.

(b) Grounding Conductors. Bare, covered or insulated equipment grounding conductors shall be permitted. Individually covered or insulated grounding conductors shall have a continuous outer finish that is either green, or green with one or more yellow stripes.

Exception No. 1: An insulated conductor larger than No. 6 shall, at the time of installation, be permitted to be permanently identified as a grounding conductor at each end and at every point where the conductor is accessible. Identification shall be accomplished by one of the following means:

a. Stripping the insulation from the entire exposed length;

b. Coloring the exposed insulation green; or

c. Marking the exposed insulation with green colored tape or green colored adhesive labels.

Exception No. 2: Where the conditions of maintenance and supervision assure that only qualified persons will service the installation, an insulated conductor in a multiconductor cable shall, at the time of installation, be permitted to be permanently identified as a grounding conductor at each end and at every point where the conductor is accessible by one of the following means:

a. Stripping the insulation from the entire exposed length;

b. Coloring the exposed insulation green; or

c. Marking the exposed insulation with green tape or green colored adhesive labels.

(c) Ungrounded Conductor. Conductors which are intended for use as ungrounded conductors, whether used as single conductors or in multiconductor cables, shall be finished to be clearly distinguishable from grounded and grounding conductors. Ungrounded conductors shall be distinguished by colors other than white, natural gray, or green; or by a combination of color plus distinguishing marking. Distinguishing markings shall also be in a color other than white, natural gray, or green, and

shall consist of a stripe or stripes or a regularly spaced series of identical marks. Distinguishing markings shall not conflict in any manner with the surface markings required by Section 310-11(b)(1).

310-11. Marking.

(a) Required Information. All conductors and cables shall be *marked to* indicate the following information, using the applicable method described in (b) below.

(1) The maximum working voltage for which the conductor was tested or approved.

(2) The proper type letter or letters for the type of wire or cable as specified elsewhere in this article, in Tables 310-13 and 310-31, and in Articles 336, 337, 338, 339, 340, and 725-40(b)(3).

(3) The manufacturer's name, trademark, or other distinctive marking by which the organization responsible for the product can be readily identified.

(4) The AWG size or circular-mil area.

(b) Method of Marking.

(1) Surface Marking. The following conductors and cables shall be durably marked on the surface *at intervals not exceeding 24 inches:*

(a) Single- and multiconductor rubber- and thermoplastic-insulated wire and cable.
(b) Nonmetallic-sheathed cable.
(c) Service-entrance cable.
(d) Underground feeder and branch-circuit cable.
(e) Tray cable.
(f) Irrigation cable.
(g) *Power-Limited Tray Cable*

(2) Marker Tape. Metal-covered multiconductor cables shall employ a marker tape located within the cable and running for its complete length.

Exception No. 1: Mineral-insulated metal-sheathed cable.

Exception No. 2: Type AC cable.

Exception No. 3: The information required in Section 310-11(a)(1), (2), and (4) above shall be permitted to be durably marked on the outer nonmetallic covering of Type MC cable at intervals not exceeding 24 inches.

Included in the group of metal-covered cables are: Type AC cable (Article 333), Type MC cable (Article 334) and lead-sheathed cable.

(3) Tag Marking. The following conductors and cables shall be marked by means of a printed tag attached to the coil, reel, or carton:

(a) Mineral-insulated, metal-sheathed cable.
(b) Switchboard wires.
(c) Metal-covered single-conductor cables.
(d) Conductors having outer surface of asbestos.
(e) Type AC cable.

(4) Optional Marking of Wire Size. For the following multiconductor cables, the information required in (a) (4) above shall be permitted to be marked on the surface of the individual insulated conductors:

(a) Type MC cable.
(b) Tray cable.

(c) Irrigation cable.
(d) Power-Limited Tray Cable.

(c) Suffixes to Designate Number of Conductors. A type letter or letters used alone shall indicate a single insulated conductor. The following letter suffixes shall indicate the following:

D - for two insulated conductors laid parallel within an outer nonmetallic covering.
M for an assembly of two or more insulated conductors twisted spirally within an outer nonmetallic covering.

B. Conductors 600 Volts, Nominal or Less

310-12. Conductor Application. Insulated conductors listed in Table 310-13 *shall be permitted for use with any of the wiring methods recognized* by Chapter 3 as specified in the table.

Thermoplastic insulation may stiffen at temperatures colder than minus 10°C (plus 14°F), requiring care be exercised during installation at such temperatures. Thermoplastic insulation may also be deformed at normal temperatures where subjected to pressure, requiring care be exercised during installation and at points of support.

310-13. Conductor Construction. Insulated conductors for use at 600 volts or less shall comply with Table 310-13.

310-15. Ampacity. The maximum continuous ampacities for copper, aluminum, and copper-clad aluminum conductors shall be as specified in Tables 310-16 through 310-19 and accompanying Notes 1 through 12.

Table 310-13. Conductor Application and Insulations

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions	Insulation	AWG or MCM	Thickness of Insulation Mils	Outer Covering
Heat-Resistant Rubber	RH	75°C 167°F	Dry locations.	Heat-Resistant Rubber	**14-12	30	*Moisture-resistant, flame-retardant, non-metallic covering
					10	45	
					8-2	60	
					1-4/0	80	
					213-500	95	
					501-1000	110	
					1001-2000	125	
Heat-Resistant Rubber	RHH	90°C 194°F	Dry locations.				
Moisture and Heat-Resistant Rubber	RHW	75°C 167°F	Dry and wet locations. For over 2000 volts insulation shall be ozone-resistant.	Moisture and Heat-Resistant Rubber	14-10	45	*Moisture-resistant, flame-retardant, non-metallic covering
					8-2	60	
					1-4/0	80	
					213-500	95	
					501-1000	110	
					1001-2000	125	
Heat-Resistant Latex Rubber	RUH	75°C 167°F	Dry locations.	90% Unmilled, Grainless Rubber	14-10	18	Moisture-resistant, flame-retardant, non-metallic covering
					8-2	25	

* Outer covering shall not be required over rubber insulations which have been specifically approved for the purpose.
** For 14-12 sizes RHH shall be 45 mils thickness insulation.
| For insulated aluminum and copper-clad aluminum conductors, the minimum size shall be No. 12. See Tables 310-16 through 310-19.

Table 310-13 (Continued)

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions	Insulation	AWG or MCM	Thickness of Insulation Mils	Outer Covering
Moisture-Resistant Latex Rubber	RUW	60°C 140°F	Dry and wet locations.	90% Unmilled, Grainless Rubber	14-10	18	Moisture-resistant, flame-retardant, non-metallic covering
					8-2	25	
Thermoplastic	T	60°C 140°F	Dry locations.	Flame-Retardant, Thermoplastic Compound	14-10	30	None
					8	45	
					6-2	60	
					1-4/0	80	
					213-500	95	
					501-1000	110	
					1001-2000	125	
Moisture-Resistant Thermoplastic	TW	60°C 140°F	Dry and wet locations.	Flame-Retardant, Moisture-Resistant Thermoplastic	14-10	30	None
					8	45	
					6-2	60	
					1-4/0	80	
					213-500	95	
					501-1000	110	
					1001-2000	125	
Heat-Resistant Thermoplastic	THHN	90°C 194°F	Dry locations.	Flame-Retardant, Heat-Resistant Thermoplastic	14-12	15	Nylon jacket or equivalent
					10	20	
					8-6	30	
					4-2	40	
					1-4/0	50	
					250-500	60	
					501-1000	70	

Table 310-13 (Continued)

Moisture- and Heat-Resistant Thermoplastic	THW	75°C 167°F 90°C 194°F	Dry and wet locations. Special applications within electric discharge lighting equipment. Limited to 1000 open-circuit volts or less. (Size 14-8 only as permitted in Section 410-31.)	Flame-Retardant, Moisture- and Heat-Resistant Thermoplastic	14-10 ..... 45 8-2 ..... 60 1-4/0 ..... 80 213-500 ..... 95 501-1000 .....110 1001-2000 125	None
Moisture- and Heat-Resistant Thermoplastic	THWN	75°C 167°F	Dry and wet locations.	Flame-Retardant, Moisture- and Heat-Resistant Thermoplastic	14-12 ..... 15 10 ..... 20 8-6 ..... 30 4-2 ..... 40 1-4/0 ..... 50 250-500 ..... 60 501-1000 70	Nylon jacket or equivalent
Moisture- and Heat-Resistant Cross-Linked Synthetic Polymer	XHHW	90°C 194°F 75°C 167°F	Dry locations. Wet locations.	Flame-Retardant Cross-Linked Synthetic Polymer	14-10 ..... 30 8-2 ..... 45 1-4/0 ..... 55 213-500 ..... 65 501-1000 ..... 80 1001-2000 95	None
Moisture-, Heat- and Oil-Resistant Thermoplastic	MTW	60°C 140°F 90°C 194°F	Machine tool wiring in wet locations as permitted in NFPA Standard No. 79. (See Article 670.) Machine tool wiring in wet locations as permitted in NFPA Standard No. 79. (See Article 670.)	Flame-Retardant, Moisture-, Heat- and Oil-Resistant Thermoplastic	(A) (B) 22-12 .... 30 15 10 ..... 30 20 8 ..... 45 30 6 ..... 60 30 4-2 ..... 60 40 1-4/0 .... 80 50 213-500 .. 95 60 501-1000 .110 70	(A) None (B) Nylon jacket or equivalent

For insulated aluminum and copper-clad aluminum conductors, the minimum size shall be No. 12. See Tables 310-16 through 310-19.

Table 310-13 (Continued)

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions	Insulation	AWG or MCM / Thickness of Insulation / Mils	Outer Covering
Perfluoro-alkoxy	PFA	90°C 194°F 200°C 392°F	Dry locations. Dry locations — special applications.	Perfluoro-alkoxy	14-10 ..... 20 8-2 ..... 30 1-4/0 45	None
Perfluoro-alkoxy	PFAH	—250°C 482°F	Dry locations only. Only for leads within apparatus or within raceways connected to apparatus. (Nickel or nickel-coated copper only.)	Perfluoro-alkoxy	14-10 ..... 20 8-2 ..... 30 1-4/0 45	None
Extruded Polytetra-fluoroethylene	TFE	—250°C 482°F	Dry locations only. Only for leads within apparatus or within raceways connected to apparatus, or as open wiring. (Nickel or nickel-coated copper only.)	Extruded Polytetra-fluoro-ethylene	14-10 ..... 20 8-2 ..... 30 1-4/0 45	None
Thermoplastic and Asbestos	TA	90°C 194°F	Switchboard wiring only.	Thermo-plastic and Asbestos	Th'pl'. Asb. 14-8 ..... 20 20 6-2 ..... 30 25 1-4/0 .....40 30	Flame-retardant, nonmetallic covering
Thermoplastic and Fibrous Outer Braid	TBS	90°C 194°F	Switchboard wiring only.	Thermo-plastic	14-10 ..... 30 8 ..... 45 6-2 ..... 60 1-4/0 80	Flame-retardant, nonmetallic covering
Synthetic Heat-Resistant	SIS	90°C 194°F	Switchboard wiring only.	Heat-Resistant Rubber	14-10 ..... 30 8 ..... 45 6-2 ..... 60 1-4/0 80	None

Table 310-13 (Continued)

Mineral Insulation (Metal Sheathed)	MI	85°C 185°F 250°C 482°F	Dry and wet locations. For special application.	Magnesium Oxide	16-10 ..... 36 9-4 ..... 50 3-250 55	Copper
Underground Feeder & Branch-Circuit Cable-Single Conductor. (For Type UF cable employing more than one conductor see Article 339.)	UF	60°C 140°F 75°C** 167°F	See Article 339	Moisture-Resistant Moisture- and Heat-Resistant	14-10 .....*60 8-2 .....*80 1-4/0 .....*95	Integral with insulation
Underground Service-Entrance Cable-Single Conductor. (For Type USE cable employing more than one conductor see Article 338.)	USE	75°C 167°F	See Article 338	Heat- and Moisture-Resistant	12-10 ..... 45 8-2 ..... 60 1-4/0 ..... 80 213-500 ..... 95 501-1000 .....110 1001-2000 125	Moisture-resistant nonmetallic covering [See 338-1 (2).]

* Includes integral jacket.

** For ampacity limitation, see 339-1(a).

The nonmetallic covering over individual rubber-covered conductors of aluminum-sheathed cable and of lead-sheathed or multiconductor cable shall not be required to be flame retardant. For Type MC cable, see Section 334-20. For nonmetallic-sheathed cable, see Section 336-2. For Type UF cable, see Section 339-1.

For insulated aluminum and copper-clad aluminum conductors, the minimum size shall be No. 12. See Tables 310-16 through 310-19.

Table 310-13 (Continued)

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions	Insulation	AWG or MCM	Thickness of Insulation Mils	Outer Covering
Silicone-Asbestos	SA	90°C 194°F —125°C 257°F	Dry locations. For special application.	Silicone Rubber	14-10 ..... 8-2 ..... 1-4/0 ..... 213-500 ..... 501-1000 ..... 1001-2000	45 60 80 95 110 125	Asbestos or glass
Fluorinated Ethylene Propylene	FEP or FEPB	90°C 194°F —200°C 392°F	Dry locations. Dry locations — special applications.	Fluorinated Ethylene Propylene	14-10 ..... 8-2	20 30	None
				Fluorinated Ethylene Propylene	14-8 ..... 6-2	14 14	Glass braid Asbestos braid
Modified Fluorinated Ethylene Propylene	FEPW	75°C 90°C	Wet locations. Dry locations.	Modified Fluorinated Ethylene Propylene	14-10 ..... 8-2	20 30	None
Modified Ethylene Tetrafluoro-ethylene	Z	90°C 194°F —150°C 302°F	Dry locations. Dry locations — special applications.	Modified Ethylene Tetrafluoro-ethylene	14-12 ..... 10 ..... 8-4 ..... 3-1 ..... 1/0-4/0	15 20 25 35 45	None
Modified Ethylene Tetrafluoro-ethylene	ZW	75°C 167°F 90°C 194°F —150°C 302°F	Wet locations. Dry locations. Dry locations — special applications.	Modified Ethylene Tetrafluoro-ethylene	14-10 ..... 8-2	30 45	None

Table 310-13 (Continued)

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions	Insulation	AWG or MCM	Thickness of Insulation	Mils	Outer Covering
Varnished Cambric	V	85°C 185°F	Dry locations only. Smaller than No. 6 by special permission.	Varnished Cambric	14-8 6-2 1-4/0 213-500 500-1000 1001-2000		45 60 80 95 110 125	Nonmetallic covering or lead-sheath
Asbestos and Varnished Cambric	AVA	110°C 230°F	Dry locations only.	Impregnated Asbestos and Varnished Cambric	14-8 (solid only) 14-8 6-2 1-4/0 213-500 501-1000 1001-2000	1st Asb. / VC — 10 15 20 25 30 30	30 30 30 30 40 40 50	AVA 2nd Asb. 20 15 20 30 40 40 50	AVL 2nd Asb. 25 25 25 30 40 40 50	AVA-asbestos braid or glass AVL-lead sheath
Asbestos and Varnished Cambric	AVL	110°C 230°F	Dry and wet locations.							
Asbestos and Varnished Cambric	AVB	90°C 194°F	Dry locations only.	Impregnated Asbestos and Varnished Cambric	18-8 6-2 1-4/0		VC 30 40 40	Asb. 20 30 40	Flame-retardant, cotton braid (switchboard wiring)
					14-8 6-2 1-4/0 213-500 501-1000 1001-2000	Asb. 10 15 20 25 30 30	VC 30 30 30 40 40 50	2nd Asb. 15 20 30 40 40 50	Flame-retardant, cotton braid

For insulated aluminum and copper-clad aluminum conductors, the minimum size shall be No. 12. See Tables 310-16 through 310-19.

Table 310-13 (Continued)

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions	Insulation	AWG or MCM	Thickness of Insulation	Mils	Outer Covering
Asbestos	A	200°C 392°F	Dry locations only. Only for leads within apparatus or within raceways connected to apparatus. Limited to 300 volts.	Asbestos	14 12-8		30 40	Without asbestos braid
Asbestos	AA	200°C 392°F	Dry locations only. Only for leads within apparatus or within raceways connected to apparatus or as open wiring. Limited to 300 volts.	Asbestos	14 12-8 6-2 1-4/0		30 30 40 60	With asbestos braid or glass
Asbestos	AI	−125°C 257°F	Dry locations only. Only for leads within apparatus or within raceways connected to apparatus. Limited to 300 volts.	Impregnated Asbestos	14 12-8		30 40	Without asbestos braid
Asbestos	AIA	−125°C 257°F	Dry locations only. Only for leads within apparatus or within raceways connected to apparatus or as open wiring.	Impregnated Asbestos	14 12-8 6-2 1-4/0 213-500 501-1000	Sol. 30 30 40 60 90	Str. 30 40 60 75 105	With asbestos braid or glass
Paper		85°C 185°F	For underground service conductors, or by special permission.	Paper				Lead sheath

For insulated aluminum and copper-clad aluminum conductors, the minimum size shall be No. 12. See Tables 310-16 through 310-19.

Table 310-16. Allowable Ampacities of Insulated Conductors Rated 0-2000 Volts, 60° to 90°C

Not More Than Three Conductors in Raceway or Cable or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)

Size AWG MCM	Temperature Rating of Conductor. See Table 310-13								Size AWG MCM
	60°C (140°F)	75°C (167°F)	85°C (185°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	85°C (185°F)	90°C (194°F)	
	TYPES RUW, T, TW, UF	TYPES FEPW, RH, RHW, RUH, THW, THWN, XHHW, USE, ZW	TYPES V, MI	TYPES TA, TBS, SA, AVB, SIS, †FEP, †FEPB, †RHH, †THHN, †XHHW*	TYPES RUW, T, TW, UF	TYPES RH, RHW, RUH, THW, THWN, XHHW, USE	TYPES V, MI	TYPES TA, TBS, SA, AVB, SIS, †RHH, †THHN, †XHHW*	
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
18	....	....	....	21	....	....	....	....	....
16	....	....	22	22	....	....	....	....	....
14	15	15	25	† 25	....	....	....	....	....
12	20	20	30	† 30	15	15	25	25	12
10	30	30	40	† 40	25	25	30	30	10
8	40	45	50	50	30	40	40	40	8
6	55	65	70	70	40	50	55	55	6
4	70	85	90	90	55	65	70	70	4
3	80	100	105	105	65	75	80	80	3
2	95	115	120	120	75	90	95	95	2
1	110	130	140	140	85	100	110	110	1
0	125	150	155	155	100	120	125	125	0
00	145	175	185	185	115	135	145	145	00
000	165	200	210	210	130	155	165	165	000
0000	195	230	235	235	155	180	185	185	0000
250	215	255	270	270	170	205	215	215	250
300	240	285	300	300	190	230	240	240	300
350	260	310	325	325	210	250	260	260	350
400	280	335	360	360	225	270	290	290	400
500	320	380	405	405	260	310	330	330	500
600	355	420	455	455	285	340	370	370	600
700	385	460	490	490	310	375	395	395	700
750	400	475	500	500	320	385	405	405	750
800	410	490	515	515	330	395	415	415	800
900	435	520	555	555	355	425	455	455	900
1000	455	545	585	585	375	445	480	480	1000
1250	495	590	645	645	405	485	530	530	1250
1500	520	625	700	700	435	520	580	580	1500
1750	545	650	735	735	455	545	615	615	1750
2000	560	665	775	775	470	560	650	650	2000

CORRECTION FACTORS

Ambient Temp. °C	For ambient temperatures over 30°C, multiply the ampacities shown above by the appropriate correction factor to determine the maximum allowable load current.								Ambient Temp. °F
31-40	.82	.88	.90	.91	.82	.88	.90	.91	86-104
41-50	.58	.75	.80	.82	.58	.75	.80	.82	105-122
51-60	....	.58	.67	.71	....	.58	.67	.71	123-141
61-70	....	.35	.52	.58	....	.35	.52	.58	142-158
71-80	....	....	.30	.41	....	....	.30	.41	159-176

† The load current rating and the overcurrent protection for these conductors shall not exceed 15 amperes for 14 AWG, 20 amperes for 12 AWG, and 30 amperes for 10 AWG copper; or 15 amperes for 12 AWG and 25 amperes for 10 AWG aluminum and copper-clad aluminum.

* For dry locations only. See 75°C column for wet locations.

Table 310-17. Allowable Ampacities of Insulated Conductors Rated 0-2000 Volts, 60° to 90°C

Single conductors in free air, based on ambient temperature of 30°C (86°F).

Size AWG MCM	Temperature Rating of Conductor. See Table 310-13								Size AWG MCM
	60°C (140°F)	75°C (167°F)	85°C (185°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	85°C (185°F)	90°C (194°F)	
	TYPES RUW, T, TW	TYPES FEPW, RH, RHW, RUH, THW, THWN, XHHW, ZW	TYPES V, MI	TYPES TA, TBS, SA, AVB, SIS, †FEP, †FEPB, †RHH, †THHN, †XHHW*	TYPES RUW, T, TW	TYPES RH, RHW, RUH, THW, THWN, XHHW	TYPES V, MI	TYPES TA, TBS, SA, AVB, SIS, †RHH, †THHN, †XHHW*	
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
18	....	....	....	25	....	....	....	....	....
16	....	....	27	27	....	....	....	....	....
14	20	20	30	30	....	....	....	....	....
12	25	25	40	40	20	20	30	30	12
10	40	40	55	55	30	30	45	45	10
8	55	65	70	70	45	55	55	55	8
6	80	95	100	100	60	75	80	80	6
4	105	125	135	135	80	100	105	105	4
3	120	145	155	155	95	115	120	120	3
2	140	170	180	180	110	135	140	140	2
1	165	195	210	210	130	155	165	165	1
0	195	230	245	245	150	180	190	190	0
00	225	265	285	285	175	210	220	220	00
000	260	310	330	330	200	240	255	255	000
0000	300	360	385	385	230	280	300	300	0000
250	340	405	425	425	265	315	330	330	250
300	375	445	480	480	290	350	375	375	300
350	420	505	530	530	330	395	415	415	350
400	455	545	575	575	355	425	450	450	400
500	515	620	660	660	405	485	515	515	500
600	575	690	740	740	455	545	585	585	600
700	630	755	815	815	500	595	645	645	700
750	655	785	845	845	515	620	670	670	750
800	680	815	880	880	535	645	695	695	800
900	730	870	940	940	580	700	750	750	900
1000	780	935	1000	1000	625	750	800	800	1000
1250	890	1065	1130	1130	710	855	905	905	1250
1500	980	1175	1260	1260	795	950	1020	1020	1500
1750	1070	1280	1370	1370	875	1050	1125	1125	1750
2000	1155	1385	1470	1470	960	1150	1220	1220	2000

CORRECTION FACTORS

Ambient Temp. °C	For ambient temperatures over 30°C, multiply the ampacities shown above by the appropriate correction factor to determine the maximum allowable load current.								Ambient Temp. °F
31-40	.82	.88	.90	.91	.82	.88	.90	.91	86-104
41-50	.58	.75	.80	.82	.58	.75	.80	.82	105-122
51-60	....	.58	.67	.71	....	.58	.67	.71	123-141
61-70	....	.35	.52	.58	....	.35	.52	.58	142-158
71-80	....	....	.30	.41	....	....	.30	.41	159-176

† The load current rating and the overcurrent protection for these conductors shall not exceed 20 amperes for 14 AWG, 25 amperes for 12 AWG, and 40 amperes for 10 AWG copper, or 20 amperes for 12 AWG and 30 amperes for 10 AWG aluminum and copper-clad aluminum.

* For dry locations only. See 75°C column for wet locations.

Table 310-18. Allowable Ampacities for Insulated Conductors Rated 110 to 250°C

Not More Than Three Conductors in Raceway or Cable
Based on Ambient Temperature of 30°C (86°F).

Size	Temperature Rating of Conductor. See Table 310-13								Size
	110°C (230°F)	125°C (257°F)	150°C (302°F)	200°C (392°F)	250°C (482°F)	110°C (230°F)	125°C (257°F)	200°C (392°F)	
	TYPES AVA, AVL	TYPES AI, AIA	TYPE Z	TYPES A, AA, FEP, FEPB, PFA	TYPES PFAH, TFE	TYPES AVA, AVL	TYPES AI, AIA	TYPES A, AA	
AWG MCM	COPPER				NICKEL OR NICKEL-COATED COPPER	ALUMINUM OR COPPER-CLAD ALUMINUM			AWG MCM
14	30	30	30	30	40	....	....	....	....
12	35	40	40	40	55	25	30	30	12
10	45	50	50	55	75	35	40	45	10
8	60	65	65	70	95	45	50	55	8
6	80	85	90	95	120	60	65	75	6
4	105	115	115	120	145	80	90	95	4
3	120	130	135	145	170	95	100	115	3
2	135	145	150	165	195	105	115	130	2
1	160	170	180	190	220	125	135	150	1
0	190	200	210	225	250	150	160	180	0
00	215	230	240	250	280	170	180	200	00
000	245	265	275	285	315	195	210	225	000
0000	275	310	325	340	370	215	245	270	0000
250	315	335	....	....	....	250	270	....	250
300	345	380	....	....	....	275	305	....	300
350	390	420	....	....	....	310	335	....	350
400	420	450	....	....	....	335	360	....	400
500	470	500	....	....	....	380	405	....	500
600	525	545	....	....	....	425	440	....	600
700	560	600	....	....	....	455	485	....	700
750	580	620	....	....	....	470	500	....	750
800	600	640	....	....	....	485	520	....	800
1000	680	730	....	....	....	560	600	....	1000
1500	785	....	....	....	....	650	....	....	1500
2000	840	....	....	....	....	705	....	....	2000

CORRECTION FACTORS

Ambient Temp. °C	For ambient temperatures over 30°C, multiply the ampacities shown above by the appropriate correction factor to determine the maximum allowable load current.								Ambient Temp. °F
31-40	.94	.95	.96	....	....	.94	.95	....	87-104
41-45	.90	.92	.94	....	....	.90	.92	....	105-113
46-50	.87	.89	.91	....	....	.87	.89	....	114-122
51-55	.83	.86	.89	....	....	.83	.86	....	123-131
56-60	.79	.83	.87	.91	.95	.79	.83	.91	132-141
61-70	.71	.76	.82	.87	.91	.71	.76	.87	142-158
71-75	.66	.72	.79	.86	.89	.66	.72	.86	159-167
76-80	.61	.68	.76	.84	.87	.61	.69	.84	168-176
81-90	.50	.61	.71	.80	.83	.50	.61	.80	177-194
91-100	....	.51	.65	.77	.80	....	.51	.77	195-212
101-120	....	....	.50	.69	.72	....	....	.69	213-248
121-140	....	....	.29	.59	.59	....	....	.59	249-284
141-160	....	....	....	....	.54	....	....	....	285-320
161-180	....	....	....	....	.50	....	....	....	321-356
181-200	....	....	....	....	.43	....	....	....	357-392
201-225	....	....	....	....	.30	....	....	....	393-437

Table 310-19. Allowable Ampacities for Insulated Conductors Rated 110 to 250°C, and for Bare and Covered Conductors

Single Conductors in Free Air,
Based on Ambient Temperature of 30°C (86°F).

Size	Temperature Rating of Conductor. See Table 310-13.										Size
	110°C (230°F)	125°C (257°F)	150°C (302°F)	200°C (392°F)	Bare and covered conductors	250°C (482°F)	110°C (230°F)	125°C (257°F)	200°C (392°F)	Bare and covered conductors	
	TYPES AVA, AVL	TYPES AI, AIA	TYPE Z	TYPES A, AA, FEP, FEPB, PFA		TYPES PFAH, TFE	TYPES AVA, AVL	TYPES AI, AIA	TYPES A, AA		
AWG MCM	COPPER					NICKEL OR NICKEL-COATED COPPER	ALUMINUM OR COPPER-CLAD ALUMINUM				AWG MCM
14	40	40	40	45	30	60	....	....	....	....	....
12	50	50	50	55	40	80	40	40	45	30	12
10	65	70	70	75	55	110	50	55	60	45	10
8	85	90	95	100	70	145	65	70	80	55	8
6	120	125	130	135	100	210	95	100	105	80	6
4	160	170	175	180	130	285	125	135	140	100	4
3	180	195	200	210	150	335	140	150	165	115	3
2	210	225	230	240	175	390	165	175	185	135	2
1	245	265	270	280	205	450	190	205	220	160	1
0	285	305	310	325	235	545	220	240	255	185	0
00	330	355	360	370	275	605	255	275	290	215	00
000	385	410	415	430	320	725	300	320	335	250	000
0000	445	475	490	510	370	850	345	370	400	290	0000
250	495	530	....	....	410	....	385	415	....	320	250
300	555	590	....	....	460	....	435	460	....	360	300
350	610	655	....	....	510	....	475	510	....	400	350
400	665	710	....	....	555	....	520	555	....	435	400
500	765	815	....	....	630	....	595	635	....	490	500
600	855	910	....	....	710	....	675	720	....	560	600
700	940	1005	....	....	780	....	745	795	....	615	700
750	980	1045	....	....	810	....	775	825	....	640	750
800	1020	1085	....	....	845	....	805	855	....	670	800
900	....	....	....	....	905	....	....	....	....	725	900
1000	1165	1240	....	....	965	....	930	990	....	770	1000
1500	1450	....	....	....	1215	....	1175	....	....	985	1500
2000	1715	....	....	....	1405	....	1425	....	....	1165	2000

CORRECTION FACTORS

Ambient Temp. °C	For ambient temperatures over 30°C, multiply the ampacities shown above by the appropriate correction factor to determine the maximum allowable load current.										Ambient Temp. °F
31-40	.94	.95	.96	....	....	....	.94	.95	....	....	87-104
41-45	.90	.92	.94	....	....	....	.90	.92	....	....	105-113
46-50	.87	.89	.91	....	....	....	.87	.89	....	....	114-122
51-55	.83	.86	.89	....	....	....	.83	.86	....	....	123-131
56-60	.79	.83	.87	.91	....	.95	.79	.83	.91	....	132-141
61-70	.71	.76	.82	.87	....	.91	.71	.76	.87	....	142-158
71-75	.66	.72	.79	.86	....	.89	.66	.72	.86	....	159-167
76-80	.61	.68	.76	.84	....	.87	.61	.69	.84	....	168-176
81-90	.50	.61	.71	.80	....	.83	.50	.61	.80	....	177-194
91-100	....	.51	.65	.77	....	.80	....	.51	.77	....	195-212
101-120	....	....	.50	.69	....	.72	....	....	.69	....	213-248
121-140	....	....	.29	.59	....	.59	....	....	.59	....	249-284
141-160	....	....	....	....	....	.54	....	....	....	....	285-320
161-180	....	....	....	....	....	.50	....	....	....	....	321-356
181-200	....	....	....	....	....	.43	....	....	....	....	357-392
201-225	....	....	....	....	....	.30	....	....	....	....	393-437

Notes to Tables 310-16 through 310-19

1. Explanation of Tables. For explanation of Type Letters, and for recognized size of conductors for the various conductor insulations, see Sections 310-12 and 310-13. For installation requirements, see Sections 310-1 through 310-9, and the various articles of this Code. For flexible cords see Tables 400-4 and 400-5.

2. Application of Tables. For open wiring on insulators and for concealed knob-and-tube wiring, the allowable ampacities of Tables 310-17 and 310-19 shall be used. For all other recognized wiring methods, the allowable ampacities of Tables 310-16 and 310-18 shall be used, unless otherwise provided in this Code.

3. Three-Wire, Single-Phase Residential Service. In a residential occupancy conductors, as listed below, shall be permitted to be utilized as three-wire, single-phase, service-entrance conductors and the three-wire, single-phase feeder that carries the total current supplied by that service.

Conductor Types and Sizes RH-RHH-RHW-THW-THWN-THHN-XHHW

Aluminum and Copper-Clad Al	Copper	Service Rating in Amps
AWG	AWG	
4	2	100
3	1	110
2	1/0	125
1	2/0	150
1/0	3/0	175
2/0	4/0	200

4. Type MC Cable. The ampacities of Type MC cables are determined by the temperature limitation of the insulated conductors incorporated within the cable. Hence the ampacities of Type MC cable may be determined from the columns in Tables 310-16 and 310-18 applicable to the type of insulated conductors employed within the cable.

5. Bare Conductors. Where bare conductors are used with insulated conductors, their allowable ampacities shall be limited to that permitted for the insulated conductors of the same size.

6. Mineral-Insulated, Metal-Sheathed Cable. The temperature limitation on which the ampacities of mineral-insulated, metal-sheathed cable are based is determined by the insulating materials used in the end seal. Termination fittings incorporating unimpregnated, organic, insulating materials are limited to 85°C operation.

7. Type MTW Machine Tool Wire. The ampacities of Type MTW wire are specified in Table 200-B of the Electrical Standard for Metalworking Machine Tools 1977 (NFPA Publication No. 79).

8. More Than 3 Conductors in a Raceway or Cable. Where the number of conductors in a raceway or cable exceed 3, the maximum allowable load current of each conductor shall be reduced as shown in the following table:

Number of Conductors	Percent of Values in Tables 310-16 and 310-18
4 thru 6	80
7 thru 24	70
25 thru 42	60
43 and above	50

Where single conductors or multiconductor cables are stacked or bundled without maintaining spacing and are not installed in raceways, the maximum allowable load current of each conductor shall be reduced as shown in the above table.

Exception No. 1: When conductors of different systems, as provided in Section 300-3, are installed in a common raceway the derating factors shown above shall apply to the number of power and lighting (Articles 210, 215, 220, and 230) conductors only.

Exception No. 2: The derating factors of Sections 210-22(c), 220-2(a) and 220-10(b) shall not apply when the above derating factors are also required.

Exception No. 3: For conductors installed in cable trays, the provisions of Section 318-10 shall apply.

9. Overcurrent Protection. Where the standard ratings and settings of overcurrent devices do not correspond with the ratings and settings allowed for conductors, the next higher standard rating and setting shall be permitted.

Exception: As limited in Section 240-3

10. Neutral Conductor.

(a) A neutral conductor which carries only the unbalanced current from other conductors, as in the case of normally balanced circuits of 3 or more conductors, shall not be counted in determining ampacities as provided for in Note 8.

(b) In a 3-wire circuit consisting of 2-phase wires and the neutral of a 4-wire, 3-phase wye-connected system, a common conductor carries approximately the same current as the other conductors and shall be counted in determining ampacities as provided in Note 8.

(c) On a 4-wire, 3-phase wye circuit where the major portion of the load consists of electric-discharge lighting there are harmonic currents present in the neutral conductor and the neutral shall be considered to be a current-carrying conductor.

11. Grounding Conductor. A grounding conductor shall not be counted in determining ampacities as provided for in Note 8.

12. Voltage Drop. The allowable ampacities in Tables 310-16 through 310-19 are based on temperature alone and do not take voltage drop into consideration.

C. Conductors Over 600 Volts, Nominal

310-30. General. In addition to the generally applicable provisions of Part A of this article, the following rules shall apply.

310-31. Construction of Conductors for Over 600 Volts. Insulated conductors for use over 600 volts, nominal, shall comply with Tables 310-31 through 310-37.

Table 310-31. Conductor Application and Insulation

Trade Name	Type Letter	Maximum Operating Temperature	Application Provision	Insulation	Outer Covering
Medium voltage solid dielectric	MV-75 MV-85 MV-90	75C 85C 90C	Dry or wet locations rated 2001 volts and higher	Thermoplastic or Thermosetting	Jacket, Sheath or Armor

Table 310-32. Thickness of Insulation for 601-2000 Volt Nonshielded Types RHH and RHW, In Mils

Conductor Size AWG-MCM	A	B
14-10*	80	60
8	80	70
6-2	95	70
1-2/0	110	90
3/0-4/0	110	90
213-500	125	105
501-1000	140	120

Note: Column A insulations are limited to natural, SBR, and butyl rubbers.

Note: Column B insulations, and composites thereof, are those approved for the purpose, such as cross-linked polyethylene and ethylene propylene rubber.

* Note: No. 12 shall be the minimum conductor size for aluminum and copper clad aluminum.

Table 310-33. Thickness of Insulation and Jacket for Nonshielded Solid Dielectric Insulated Conductors Rated 2001 to 8000 Volts in Mils

Conductor Size AWG-MCM	2001-5000 Volts						5001-8000 Volts 100 Percent Insulation Level Wet or Dry Locations		
	Dry Locations Single Conductor			Wet or Dry Locations			Single Conductor		Multi-Conductor*
	Without Jacket	With Jacket		Single Conductor		Multi-Conductor			
	Insulation	Insulation	Jacket	Insulation	Jacket	Insulation	Insulation	Jacket	Insulation
8	110	90	30	125	80	90	180	80	180
6	110	90	30	125	80	90	180	80	180
4-2	110	90	45	125	80	90	180	95	180
1-2/0	110	90	45	125	80	90	180	95	180
3/0-4/0	110	90	65	125	95	90	180	110	180
213-500	120	90	65	140	110	90	210	110	210
501-750	130	90	65	155	125	90	235	125	235
751-1000	130	90	65	155	125	90	250	140	250

* Note: Under a common overall covering such as a jacket, sheath or armor.

Table 310-34. Thickness of Insulation for Shielded Solid Dielectric Insulated Conductors Rated 2001 to 35,000 Volts, In Mils

Conductor Size AWG — MCM	2001-5000 Volts	5001-8000		8001-15,000		15,001-25,000		25,001-28,000	28,001-35,000
		100* Percent Insulation level	133* Percent Insulation level	100* Percent Insulation level	133* Percent Insulation level	100* Percent Insulation level	133* Percent Insulation level	100* Percent Insulation level	100* Percent Insulation level
8	90	115	140	175	215	260	345	280	345
6-4	90	115	140	175	215	260	345	280	345
2	90	115	140	175	215	260	345	280	345
1	90	115	140	175	215	260	345	280	345
1/0-1000	90	115	140	175	215	260	345	280	345

* *DEFINITIONS:*

100 Percent Insulation Level. Cables in this category shall be permitted to be applied where the system is provided with relay protection such that ground faults will be cleared as rapidly as possible, but in any case within 1 minute. While these cables are applicable to the great majority of cable installations which are on grounded systems, they shall be permitted to be used also on other systems for which the application of cables is acceptable provided the above clearing requirements are met in completely de-energizing the faulted section.

133 Percent Insulation Level. This insulation level corresponds to that formerly designated for ungrounded systems. Cables in this category shall be permitted to be applied in situations where the clearing time requirements of the 100 percent level category cannot be met, and yet there is adequate assurance that the faulted section will be de-energized in a time not exceeding 1 hour. Also they shall be permitted to be used when additional insulation strength over the 100 percent level category is desirable.

Table 310-35. Thickness of Varnished-Cambric Insulation for Single-Conductor Cable, In Mils

Conductor Size AWG or MCM	For Voltages Not Exceeding				
	1000	2000	3000	4000	5000
14	60	..	..	..	..
12	860	80	..	..	..
10	60	80	95	..	..
8-2	60	80	95	110	140
1-4/0	80	95	95	110	140
213-500	95	95	110	125	155
501-1000	110	110	110	125	155
1001-2000	125	125	125	140	155

Table 310-36. Thickness of Varnished-Cambric Insulation for Multiconductor Cable, in Mils

Conductor Size AWG or MCM	For Voltages Not Exceeding									
	1000		2000		3000		4000		5000	
	C	B	C	B	C	B	C	B	C	B
14	60	0	..	..	..	..	..	..	..	..
12	60	0	80	0	..	..	..	..	..	..
10	60	0	80	0	80	30	..	..	..	..
8-2	60	0	80	0	80	30	95	45	95	60
1-4/0	80	0	95	0	95	30	95	45	95	60
213-500	95	0	95	0	95	30	95	45	110	60
501-1000	95	30	95	30	95	45	95	60	110	60
1001-2000	110	30	110	30	110	45	110	60	110	80

The thickness given in columns headed "C" are for the insulation on the individual conductors. Those given in the columns headed "B" are for the thickness of the over-all belt of insulation.

Table 310-37

Thickness of Asbestos and Varnished-Cambric Insulation for Single-Conductor Cable, Types AVA, AVB, and AVL, in Mils

Conductor	Asbestos 1st Wall	Varnished Cambric					Asbestos 2nd Wall
	For Voltages Not Exceeding						
AWG or MCM	1000-5000	1000	2000	3000	4000	5000	1000-5000
14-2	15	45	60	80	100	120	25
1-4/0	20	45	60	80	100	120	30
213-500	25	45	60	80	100	120	40
501-1000	30	45	60	80	100	120	40
1001-2000	30	55	75	95	115	140	50

310-38. Ampacity. The maximum continuous ampacities for copper and aluminum solid dielectric insulated conductors rated 2001 to 35000 volts shall be as given in Tables 310-39 through 310-54 and accompanying notes, while for conductors rated 601 to 2000 volts the maximum continuous ampacities shall be as given in Tables 310-16 through 310-19 and their accompanying notes.

Table 310-39

Allowable Ampacities for Insulated Single Copper Conductor Isolated in Air

Based on Conductor Temperature of 90°C and Ambient Air Temperature of 40°C

Conductor Size AWG-MCM	2001-5000 Volts Ampacity	5001-15,000 Volts Ampacity	15,001-35,000 Volts Ampacity
8	83	..	..
6	110	110	..
4	145	150	..
2	190	195	..
1	225	225	225
1/0	260	260	260
2/0	300	300	300
3/0	345	345	345
4/0	400	400	395
250	445	445	440
350	550	550	545
500	695	685	680
750	900	885	870
1000	1075	1060	1040
1250	1230	1210	1185
1500	1365	1345	1315
1750	1495	1470	1430
2000	1605	1575	1535

Table 310-40

Allowable Ampacities for Insulated Single Aluminum Conductor Isolated in Air

Based on Conductor Temperature of 90°C and Ambient Air Temperature of 40°C

Conductor Size AWG-MCM	2001-5000 Volts Ampacity	5001-15,000 Volts Ampacity	15,001-35,000 Volts Ampacity
8	64	..	..
6	85	87	..
4	115	115	..
2	150	150	..
1	175	175	175
1/0	200	200	200
2/0	230	235	230
3/0	270	270	270
4/0	310	310	310
250	345	345	345
350	430	430	430
500	545	535	530
750	710	700	685
1000	855	840	825
1250	980	970	950
1500	1105	1085	1060
1750	1215	1195	1165
2000	1320	1295	1265

Chapter 4. Equipment for General Use

ARTICLE 400 – FLEXIBLE CORDS AND CABLES

A. General

400-1. Scope. This article covers general requirements, applications, and construction specifications for flexible cords and flexible cables.

400-2. Other Articles. Flexible cords and flexible cables shall comply with this article and with the applicable provisions of other articles of this Code.

400-3. Suitability. Flexible cords and cables and their associated fittings shall be suitable for the conditions of use and location.

400-4. Types. Flexible cords and flexible cables shall conform to the description in Table 400-4. Types of flexible cords and flexible cables other than those listed in the table shall be the subject of special investigations and shall not be used before being approved.

400-5. Ampacity of Flexible Cords and Cables. Table 400-5 gives the allowable ampacity for not more than 3 current-carrying conductors in a cord. If the number of current-carrying conductors in a cord is from 4 to 6, the allowable ampacity of each conductor shall be reduced to 80 percent of the values for not more than 3 current-carrying conductors in the table. A conductor used for equipment grounding and a neutral conductor which carries only the unbalanced current from other conductors, as in the case of normally balanced circuits of 3 or more conductors, shall not be considered as current-carrying conductors.

Where a single conductor is used for both equipment grounding and to carry unbalanced current from other conductors, as provided for in Section 250-60 for electric ranges and electric clothes dryers, it shall not be considered as a current-carrying conductor.

Notes to Table 400-4

1. Except for Types SP-1, SP-2, SP-3, SPT-1, SPT-2, SPT-3, HPN, TP, TPT, SRD (3-conductor) and SRDT (3-conductor), individual conductors are twisted together.

2. Cables constructed differently than specified herein and listed as component parts of a data processing system shall be permitted.

3. Types TP, TPT, TS, and TST shall be permitted in lengths not exceeding 8 feet when attached directly, or by means of a special type of plug, to a portable appliance rated at 50 watts or less and of such nature that extreme flexibility of the cord is essential.

4. Rubber-filled or varnished cambric tapes shall be permitted as a substitute for the inner braids.

5. Types S, SO, ST, and STO shall be permitted for use on theater stages, in garages, and elsewhere where flexible cords are permitted by this Code.

6. Traveling cables for operating, control and signaling circuits shall have one or more nonmetallic fillers or shall have a supporting filler of stranded steel wires having its own protective braid or cover. Cables exceeding 100 feet between supports shall have steel supporting fillers, except in locations subject to excessive moisture or corrosive vapors

(Notes continued on page 238)

Table 400-4. Flexible Cords and Cables
(See Section 400-4)

Trade Name	Type Letter	Size AWG	No. of Conductors	Insulation	Nominal *Insulation Thickness AWG	Nominal *Insulation Thickness Mils	Braid on Each Conductor	Outer Covering	Use	Use	Use
Parallel Tinsel Cord	TP See Note 3	27	2	Rubber	27	30	None	Rubber	Attached to an Appliance	Damp Places	Not Hard Usage
	TPT See Note 3	27	2	Thermo-plastic			None	Thermo-plastic	Attached to an Appliance	Damp Places	Not Hard Usage
Jacketed Tinsel Cord	TS See Note 3	27	2	Rubber	27	15	None	Rubber	Attached to an Appliance	Damp Places	Not Hard Usage
	TST See Note 3	27	2	Thermo-plastic			None	Thermo-plastic	Attached to an Appliance	Damp Places	Not Hard Usage
Asbestos-Covered Heat-Resistant Cord	AFC	18-10	2 or 3	Impreg-nated Asbestos	18-14	30	Cotton or Rayon	None	Pendant	Dry Places	Not Hard Usage
			2		12-10	45	None	Cotton, Rayon or Saturated Asbestos			
	AFPD		2 or 3								

See Notes 1 through 9 preceding and following table.
* See Note 9.

Table 400-4 (Continued)

Cotton-Covered Heat-Resistant Cord		18-10	2 or 3	Impregnated Cotton	18-14	30	Cotton or Rayon	None	Pendant	Dry Places	Not Hard Usage
			2		12-10	45	None	Cotton or Rayon			
	CFPD		2 or 3								
All Rubber Parallel Cord	SP-1 See Note 7	18	2 or 3	Rubber	18	30	None	Rubber	Pendant or Portable	Damp Places	Not Hard Usage
	SP-2 See Note 7	18-16			18-16	45					
	SP-3 See Note 7	18-12		Rubber	18-16 14 12 10	60 80 95 110	None	Rubber	Refrigerators or Room Air Conditioners	Damp Places	Not Hard Usage
All Plastic Parallel Cord	SPT-1 See Note 7	18	2 or 3	Thermoplastic	18	30	None	Thermoplastic	Pendant or Portable	Damp Places	Not Hard Usage
	SPT-2 See Note 7	18-16			18-16	45					
	SPT-3 See Note 7	18-10		Thermoplastic	18-16 14 12 10	60 80 95 110	None	Thermoplastic	Refrigerators or Room Air Conditioners	Damp Places	Not Hard Usage

See Notes 1 through 9 preceding and following table.
* See Note 9.

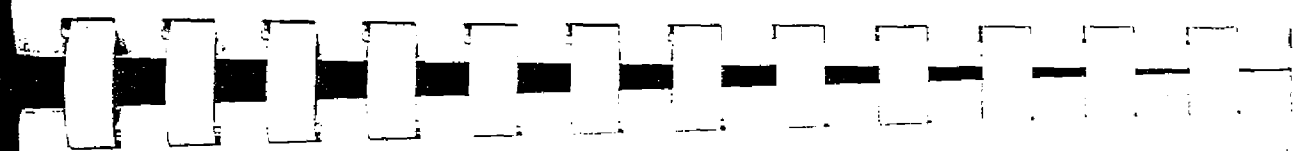

Table 400-4 (Continued)

Trade Name	Type Letter	Size AWG	No. of Conductors	Insulation	Nominal *Insulation Thickness AWG	Nominal *Insulation Thickness Mils	Braid on Each Conductor	Outer Covering	Use		
Lamp Cord	C	18-10	2 or more	Rubber	18-16	30	Cotton	None	Pendant or Portable	Dry Places	Not Hard Usage
Twisted Portable Cord	PD	18-10	2 or more	Rubber	14-10	45	Cotton	Cotton or Rayon	Pendant or Portable	Dry Places	Not Hard Usage
Vacuum Cleaner Cord	SV See Note 7	18-17	2 or 3	Rubber	18-17	15	None	Rubber	Pendant or Portable	Damp Places	Not Hard Usage
	SVO							Oil-Resistant Compound			
	SVT See Note 7			Rubber or Thermoplastic				Thermoplastic			
	SVTO See Note 7							Oil-Resistant Thermoplastic			
Junior Hard Service Cord	SJ	18-10	2, 3, or 4	Rubber	10	45	None	Rubber	Pendant or Portable	Damp Places	Hard Usage
	SJO				18-12	30		Oil-Resistant Compound			
	SJT			Thermoplastic or Rubber	18-12	30		Thermoplastic			
	SJTO				10	45		Oil-Resistant Thermoplastic			

See Notes 1 through 9 preceding and following table.
* See Note 9.

Table 400-4 (Continued)

Hard Service Cord	S See Note 5	18-2	2 or more	Rubber	18-16 (Rubber)	30	None	Rubber	Pendant or Portable	Damp Places	Extra Hard Usage
					18-16 (Latex)	15					
					14-10 (Rubber)	45		Oil Resistant Compound			
					14-10 (Latex)	18					
					8- 2 (Rubber)	60					
	SO										
	ST			Thermo-plastic or Rubber	18-16	30		Thermoplastic			
	STO				14-10	45					
					8- 2	60		Oil Resistant Thermoplastic			
Rubber-Jacketed Heat-Resistant Cord	AFSJ	18-16	2 or 3	Impregnated Asbestos	18-14	30	None	Rubber	Portable Heaters	Damp Places	Hard Usage
	AFS	18-16-14									Extra Hard Usage
Heater Cord	HPD	18-12	2, 3 or 4	Rubber or Thermoplastic with Asbestos or All Neoprene	Rubber or Thermoplastic 18-16	15	None	Cotton or Rayon	Portable Heaters	Dry Places	Not Hard Usage
					14-12	30					

See Notes 1 through 9 preceding and following table.
* See Note 9.

Table 400-4 (Continued)

Trade Name	Type Letter	Size AWG	No. of Conductors	Insulation	*Insulation Thickness AWG	*Insulation Thickness Mils	Braid on Each Conductor	Outer Covering	Use		
Rubber Jacketed Heater Cord	HSJ	18-12	2, 3 or 4	Rubber with Asbestos	18-16	15	None	Cotton and Rubber	Portable Heaters	Damp Places	Hard Usage
					14-12	30					
				All Rubber	18-16	30					
					14-12	45					
Jacketed Heater Cord	HSJO	18-12	2, 3 or 4	Rubber with Asbestos	18-16	15	None	Cotton and Oil-Resistant Compound	Portable	Damp Places	Hard Usage
	HS	14-12			14-12	30					
	HSO	14-12		All Rubber	18-16	30		Cotton and Rubber			Extra Hard Usage
					14-12	45					
								Cotton and Oil-Resistant Compound			
Parallel Heater Cord	HPN See Note 7	18-12	2 or 3	Thermo-setting	18-16	45	None	Thermosetting	Portable	Damp Places	Not Hard Usage
					14	80					
					12	95					
Range, Dryer Cable	SRD	10-4	3 or 4	Rubber	10- 4	45	None	Rubber	Portable	Damp Places	Ranges, Dryers
	SRDT	10-4	3 or 4	Thermo-plastic			None	Thermoplastic	Portable	Damp Places	Ranges, Dryers

See Notes 1 through 9 preceding and following table.
* See Note 9.

Table 400-4 (Continued)

Data Processing Cable	DP See Note 2	32 Min.	2 or More	Thermoplastic, Rubber or Cross-linked Synthetic Polymer	32-27 (50V) 26-23 (50V) 22-20 (50V) 32-16 (300V) 14-10 (300V) 8- 2 (300V)	8 12 16 20 30 60	None	Thermoplastic, Rubber or Cross-linked Synthetic Polymer	Data Processing Systems	Dry Places	Power and Signaling Circuits
Elevator Cable	E See Note 6	20-14	2 or More	Rubber	20-16	20	Cotton	Three Cotton, Outer one Flame-Retardant & Moisture-Resist. See Note 4	Elevator Lighting and Control	Non-Hazardous Locations	
	EO See Note 6				14	30		One Cotton and a Neoprene Jacket See Note 4	Elevator Lighting and Control	Hazardous Locations	
Elevator Cable	EN See Note 6	20-14	2 or More	Rubber	20-16	20	Flexible Nylon Jacket	Three Cotton, Outer one Flame-Retardant & Moisture-Resist. See Note 4	Elevator Lighting and Control	Non-Hazardous Locations	
								One Cotton and a Neoprene or Thermoplastic Jacket See Note 4		Hazardous Locations	

See Notes 1 through 9 preceding and following table.
* See Note 9.

Table 400-4 (Continued)

Trade Name	Type Letter	Size AWG	No. of Conductors	Insulation	Nominal *Insulation Thickness		Braid on Each Conductor	Outer Covering		Use
					AWG	Mils				
Elevator Cable	ET See Note 6	20-14	2 or More	Thermoplastic	20-16	20	Rayon	Three Cotton, Outer one Flame-Retardant & Moisture-Resist. See Note 4		Non-Hazardous Locations
	ETLB See Note 6				14	30	None			
	ETP See Note 6			Thermoplastic			Rayon	Thermoplastic		Hazardous Locations
	ETT See Note 6			Thermoplastic			None	One Cotton and a Thermoplastic Jacket		

See Notes 1 through 9 preceding and following table.
* See Note 9.

ARTICLE 402 – FIXTURE WIRES

402-1. Scope. This article covers general requirements and construction specifications for fixture wires.

402-2. Other Articles. Fixture wires shall comply with this article and also with the applicable provisions of other articles of this Code.

For application in lighting fixtures see Article 410.

402-3. Approved Types. Fixture wires shall be of a type listed in Table 402-3, and they shall comply with all requirements of that table. The fixture wires listed in Table 402-3 are all suitable for 600 volts unless otherwise specified.

Thermoplastic insulation may stiffen at temperatures colder than minus 10°C (plus 14°F), requiring care be exercised during installation at such temperatures. Thermoplastic insulation may also be deformed at normal temperatures where subjected to pressure, requiring care be exercised during installation and at points of support.

402-5. Ampacity of Fixture Wires. The ampacity of fixture wire shall not exceed the following:

Table 402-5

Size (AWG)	Ampacity
18	6
16	8
14	17
12	23
10	28

No conductor shall be used under such conditions that its operating temperature will exceed the temperature specified in Table 402-3 for the type of insulation involved.

402-6. Minimum Size. Fixture wires shall not be smaller than No. 18.

402-7. Number of Conductors In Conduit. The number of fixture wires permitted in a single conduit shall be as given in Table 2 of Chapter 9.

402-8. Grounded-Conductor Identification. One conductor of fixture wires which is intended to be used as a grounded conductor shall be identified by means of stripes or by the means described in Sections 400-22(a) through (e).

402-9. Marking.

(a) Required Information. All fixture wires shall be marked to indicate the information required in Section 310-11(a).

(b) Method of Marking. Thermoplastic-insulated fixture wire shall be durably marked on the surface at intervals not exceeding 24 inches. All other fixture wire shall be marked by means of a printed tag attached to the coil, reel, or carton.

402-10. Uses Permitted. Fixture wires shall be permitted: (1) for installation in lighting fixtures and in similar equipment where enclosed or pro-

(Continued on page 248)

Table 402-3. Fixture Wire

Trade Name	Type Letter	Insulation	Thickness of Insulation AWG	Thickness of Insulation Mils	Outer Covering	Max. Operating Temp.	Application Provisions
Heat-Resistant Rubber-Covered Fixture Wire Solid or 7-Strand	RFH-1	Heat-Resistant Rubber	18	15	Nonmetallic Covering	75°C 167°F	Fixture wiring. Limited to 300 volts.
	RFH-2	Heat-Resistant Rubber	18-16	30	Nonmetallic Covering	75°C 167°F	Fixture wiring, and as permitted in Sections 725-16 and 760-16.
		Heat-Resistant Latex Rubber	18-16	18			
Heat-Resistant Rubber-Covered Fixture Wire Flexible Stranding	FFH-1	Heat-Resistant Rubber	18	15	Nonmetallic Covering	75°C 167°F	Fixture wiring. Limited to 300 volts.
	FFH-2	Heat-Resistant Rubber	18-16	30	Nonmetallic Covering	75°C 167°F	Fixture wiring, and as permitted in Sections 725-16 and 760-16.
		Heat-Resistant Latex Rubber	18-16	18			
Thermoplastic-Covered Fixture Wire —Solid or Stranded	TF	Thermoplastic	18-16	30	None	60°C 140°F	Fixture wiring, and as permitted in Sections 725-16 and 760-16.
Thermoplastic-Covered Fixture Wire —Flexible Stranding	TFF	Thermoplastic	18-16	30	None	60°C 140°F	Fixture wiring, and as permitted in Sections 725-16 and 760-16.

Table 402-3 (Continued)

Heat-Resistant Thermoplastic-Covered Fixture Wire—Solid or Stranded	TFN	Thermoplastic	18-16 15		Nylon Jacketed or equivalent	90°C 194°F	Fixture wiring, and as permitted in Sections 725-16 and 760-16.
Heat-Resistant Thermoplastic-Covered Fixture Wire—Flexible Stranded	TFFN	Thermoplastic	18-16 15		Nylon Jacketed or equivalent	90°C 194°F	Fixture wiring, and as permitted in Sections 725-16 and 760-16.
Cotton-Covered, Heat-Resistant, Fixture Wire	CF	Impregnated Cotton	18-14 30		None	90°C 194°F	Fixture wiring. Limited to 300 volts.
Asbestos Covered Heat-Resistant Fixture Wire	AF	Impregnated Asbestos or Moisture Resistant Insulation and Impregnated Asbestos	12-10	Thickness of Moisture-Resistant Insulation Mils: — / 20	Thickness of Asbestos Mils: 45 / 10	None	150°C 302°F	Fixture Wire Limited to 300 Volts And Indoor Dry Location.
			12-10	— / 25	45 / 20			

Table 402-3 (Continued)

Trade Name	Type Letter	Insulation	AWG	Thickness of Insulation Mils	Outer Covering	Max. Operating Temp.	Application Provisions
Silicone Insulated Fixture Wire Solid or 7-Strand	SF-1	Silicone Rubber	18	15	Nonmetallic Covering	200°C 392°F	Fixture wiring. Limited to 300 volts.
	SF-2	Silicone Rubber	18-14	30	Nonmetallic Covering	200°C 392°F	Fixture wiring, and as permitted in Sections 725-16 and 760-16.
Silicone Insulated Fixture Wire Flexible Stranding	SFF-1	Silicone Rubber	18	15	Nonmetallic Covering	150°C 302°F	Fixture wiring. Limited to 300 volts.
	SFF-2	Silicone Rubber	18-14	30	Nonmetallic Covering	150°C 302°F	Fixture wiring, and as permitted in Sections 725-16 and 760-16.
Fluorinated Ethylene Propylene Fixture Wire Solid or 7-Strand	PF	Fluorinated Ethylene Propylene	18-14	20	None	200°C 392°F	Fixture wiring, and as permitted in Sections 725-16 and 760-16.
	PGF		18-14	14	Glass Braid		
Fluorinated Ethylene Propylene Fixture Wire Flexible Stranding	PFF	Fluorinated Ethylene Propylene	18-14	20	None	150°C 302°F	Fixture wiring, and as permitted in Sections 725-16 and 760-16.
	PGFF		18-14	14	Glass Braid		

Table 402-3 (Continued)

Tape Insulated Fixture Wire Solid or 7-Strand	KF-1	Aromatic Polyimide Tape	18-10 ..... 5.5	None	200°C 392°C	Fixture wiring. Limited to 300 volts.
	KF-2	Aromatic Polyimide Tape	18-10 ..... 8.4	None	200°C 392°F	Fixture wiring.
Tape Insulated Fixture Wire Flexible Stranding	KFF-1	Aromatic Polyimide Tape	18-10 ..... 5.5	None	200°C 392°F	Fixture wiring. Limited to 300 volts.
	KFF-2	Aromatic Polyimide Tape	18-10 ..... 8.4	None	200°C 392°F	Fixture wiring.
ECTFE Solid or 7-Strand	HF	Ethylene Chloro Trifluoro Ethylene	18-14 15	None	150°C 302°F	Fixture wiring.
ECTFE Flexible Standing	HFF	Ethylene Chloro Trifluoro Ethylene	18-14 15	None	150°C 302°F	Fixture wiring.
Modified ETFE Solid or 7-Strand	ZF	Modified Ethylene Tetrafluoro-ethylene	18-14 15	None	150°C 302°F	Fixture wire, and as permitted in Sections 725-16 and 760-16.
Flexible Stranding	ZFF	Modified Ethylene Tetrafluoro-ethylene	18-14 15	None	150°C 302°F	Fixture wire, and as permitted in Sections 725-16 and 760-16.

Table 402-3 (Continued)

Trade Name	Type Letter	Insulation	Thickness of Insulation AWG	Thickness of Insulation Mils	Outer Covering	Max. Operating Temp.	Application Provisions
Extruded Polytetra-fluoroethylene Solid or 7-Strand (Nickel or Nickel Coated Copper)	PTF	Extruded Polytetra-fluoro-ethylene	18-14	20	None	250°C 482°F	Fixture wire, and as permitted in Sections 725-16 and 760-16. (Nickel or nickel-coated copper)
Extruded Polytetra-fluoroethylene Flexible Stranding (No. 26-36 AWG Silver or Nickel Coated Copper)	PTFF	Extruded Polytetra-fluoro-ethylene	18-14	20	None	150°C 302°F	Fixture wire, and as permitted in Sections 725-16 and 760-16. (Silver or nickel-coated copper)
Perfluoro-alkoxy Solid or 7-strand (Nickel or Nickel-Coated Copper)	PAF	Perfluoro-alkoxy	18-14	20	None	250°C 482°F	Fixture wire, and as permitted in Sections 725-16 and 760-16. (Nickel or nickel-coated copper)
Perfluoro-alkoxy Flexible Stranding	PAFF	Perfluoro-alkoxy	18-14	20	None	150°C 302°F	Fixture wire, and as permitted in Sections 725-16 and 760-16.