First Revision No. 8030-NFPA 70-2018 [Global Input]

****Insert New Article 311 Per Attached Word Doc****

****Insert Revised and Reorganized Article 310 Per Attached Word Doc****

******Article 328 will be relocated to Article 311******

Article 311 Medium Voltage Cable

Part I. General

311.1 Scope. This article covers the use, installation, construction specifications and ampacities for medium voltage conductors and cable, Type MV. 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.

311.2 Definitions.

Medium Voltage Cable, Type MV. A single or multiconductor solid dielectric insulated cable rated 2001 volts up to and including 35,000 volts, nominal.

Electrical Ducts. Electrical conduits, or other raceways round in cross section, that are suitable for use underground or embedded in concrete.

Thermal Resistivity. As used in this Code, the heat transfer capability through a substance by conduction.

Informational Note: Thermal resistivity is the reciprocal of thermal conductivity and is designated Rho, which is expressed in the units °C-cm/W.

311.6 Listing Requirements. Type MV cables and associated fittings shall be listed.

Part II. Construction Specifications

311.10 Conductor Constructions and Applications. Type MV cables shall comply with the applicable provisions as follows:

(A) Conductor Application and Insulation. Conductor Application and Insulation Rated 2001 Volts and Higher shall comply with Table 311.10(A).

(B) Thickness of Insulation and Jacket for Nonshielded Insulated Conductors. Thickness of Insulation and Jacket for Nonshielded Solid Dielectric Insulated Conductors Rated 2001 to 5000 Volts shall comply with Table 311.10(B).

(C) Thickness of Insulation for Shielded Insulated Conductors. Thickness of Insulation for Shielded Solid Dielectric Insulated Conductors Rated 2001 to 35,000 Volts shall comply with Table 311.10(C) and the following:

(1) 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 that 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.

(2) 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 in 100 percent insulation level applications where additional insulation is desirable.

(3) 173 Percent Insulation Level. Cables in this category shall be permitted to be applied under all of the following conditions:

(1) In industrial establishments where the conditions of maintenance and supervision ensure that only

qualified persons service the installation

(2) Where the fault clearing time requirements of the 133 percent level category cannot be met

(3) Where an orderly shutdown is essential to protect equipment and personnel

(4) There is adequate assurance that the faulted section will be de-energized in an orderly shutdown

Also, cables with this insulation thickness shall be permitted to be used in 100 or 133 percent insulation level applications where additional insulation strength is desirable.

INSERT --> Table 311.10(A) Conductor Application and Insulation Rated 2001 Volts and Higher

INSERT --> Table 311.10(B) Thickness of Insulation and Jacket for Nonshielded Solid Dielectric Insulated Conductors Rated 2001 to 5000 Volts

INSERT --> Table 311.10(C) Thickness of Insulation for Shielded Solid Dielectric Insulated Conductors Rated 2001 to 35,000 Volts

311.12 Conductors.

(A) Minimum Size of Conductors. The minimum size of conductors shall be as shown in Table 311.12(A), except as permitted elsewhere in this Code.

INSERT --> Table 311.12(A) Minimum Size of Conductors

(B) Conductor Material. Conductors shall be of aluminum, copper-clad aluminum, or copper unless otherwise specified.

(C) Stranded Conductors. Where installed in raceways, conductors not specifically permitted or required elsewhere in this Code to be solid, shall be stranded.

311.14 Conductor Identification.

Conductors that are intended for use as ungrounded conductors, whether used as a single conductor or in multiconductor cables, shall be finished to be clearly distinguishable from grounded and grounding conductors. Distinguishing markings shall not conflict in any manner with the surface markings required by 311.16(B)(1). Branch-circuit ungrounded conductors shall be identified in accordance with 210.5(C). Feeders shall be identified in accordance with 215.12.

311.16 Marking.

(A) Required Information. All conductors and cables shall be marked to indicate the following information, using the applicable method described in 311.16(B):

(1) The maximum rated voltage.

(2) The proper type letter or letters for the type of wire or cable as specified elsewhere in this Code.

(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.

Informational Note: See Conductor Properties, Table 8 of Chapter 9, for conductor area expressed in SI units for conductor sizes specified in AWG or circular mil area.

(B) Method of Marking.

(1) Surface Marking. conductors and cables shall be durably marked on the surface. The AWG size or circular mil area shall be repeated at intervals not exceeding 610 mm (24 in.). All other markings shall be repeated at intervals not exceeding 1.0 m (40 in.).

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

(3) Tag Marking. Metal-covered, single-conductor cables shall be marked by means of a printed tag attached to the reel.

(4) Optional Marking of Wire Size. The information required in 310.120(A)(4) shall be permitted to be marked on the surface of the individual insulated conductors for multiconductor Type MC cable.

(C) Optional Markings. All conductors and cables contained in Chapter 3 shall be permitted to be surface marked to indicate special characteristics of the cable materials. These markings include, but are not limited to, markings for limited smoke, sunlight resistant, and so forth.

Part III. Installation

311.30 Installation. Type MV cable shall be installed, terminated, and tested by qualified persons.

Informational Note: Information about accepted industry practices and installation procedures for medium-voltage cable are described in ANSI/NECA/NCSCB 600-2014, Standard for Installing and Maintaining Medium-Voltage Cable and in IEEE 576-2000, Recommended Practice for Installation, Termination, and Testing of Insulated Power Cables as Used in Industrial and Commercial Applications

311.32 Uses Permitted. Type MV cable shall be permitted for use on power systems rated up to and including 35,000 volts, nominal, as follows:

(1) In wet or dry locations.

(2) In raceways.

(3) In cable trays, where identified for the use, in accordance with 392.10, 392.20(B), (C), and (D), 392.22(C), 392.30(B)(1), 392.46, 392.56, and 392.60. Type MV cable that has an overall metallic sheath or armor, complies with the requirements for Type MC cable, and is identified as “MV or MC” shall be permitted to be installed in cable trays in accordance with 392.10(B)(2).

(4) In messenger-supported wiring in accordance with Part II of Article 396.

(5) As exposed runs in accordance with 300.37. Type MV cable that has an overall metallic sheath or armor, complies with the requirements for Type MC cable, and is identified as “MV or MC” shall be permitted to be installed as exposed runs of metal-clad cable in accordance with 300.37.

(6) Corrosive conditions where exposed to oils, greases, vapors, gases, fumes, liquids, or other substances having a deleterious effect on the conductor or insulation shall be of a type suitable for the application.

(7) Conductors in parallel in accordance with 310.10(H).

(8) Type MV Cable used where exposed to direct sunlight shall be identified for the use.

Informational Note: The “Uses Permitted” is not an all-inclusive list.

311.36 Direct-Burial Conductors. Type MV cables used for direct burial applications shall be of a type identified for such use and installed in accordance with 300.50.

Cables shall be shielded.

Exception No. 1: Nonshielded multiconductor cables rated 2001– 2400 volts shall be permitted if the cable has an overall metallic sheath or armor.

The metallic shield, sheath, or armor shall be connected to a grounding electrode conductor, grounding busbar, or a grounding electrode.

Exception No. 2: Airfield lighting cable used in series circuits that are rated up to 5000 volts and are powered by regulators shall be permitted to be nonshielded.

Informational Note to Exception No. 2: Federal Aviation Administration (FAA) Advisory Circulars (ACs) provide additional practices and methods for airport lighting.

311.40 Support. Type MV cable terminated in equipment or installed in pull boxes or vaults shall be secured and supported by metallic or nonmetallic supports suitable to withstand the weight by cable ties listed and identified for securement and support, or other approved means, at intervals not exceeding 1.5 m (5 ft) from terminations or a maximum of 1.8 m (6 ft) between supports.

311.44 Shielding. Nonshielded, ozone-resistant insulated conductors with a maximum phase-to-phase voltage of 5000 volts shall be permitted in Type MC cables in industrial establishments where the conditions of maintenance and supervision ensure that only qualified persons service the installation. For other establishments, solid dielectric insulated conductors operated above 2000 volts in permanent installations shall have ozone resistant insulation and shall be shielded. All metallic insulation shields shall be connected to a grounding electrode conductor, a grounding busbar, an equipment grounding conductor, or a grounding electrode.

Informational Note: The primary purposes of shielding are to confine the voltage stresses to the insulation, dissipate insulation leakage current, drain off the capacitive charging current, and carry ground-fault current to facilitate operation of ground-fault protective devices in the event of an electrical cable fault.

Exception No. 1: Nonshielded insulated conductors listed by a qualified testing laboratory shall be permitted for use up to 2400 volts under the following conditions:

(a) Conductors shall have insulation resistant to electric discharge and surface tracking, or the insulated conductor(s) shall be covered with a material resistant to ozone, electric discharge, and surface tracking.

(b) Where used in wet locations, the insulated conductor(s) shall have an overall nonmetallic jacket or a

continuous metallic sheath.

(c) Insulation and jacket thicknesses shall be in accordance with Table 311.10(B).

Exception No. 2: Nonshielded insulated conductors listed by a qualified testing laboratory shall be permitted for use up to 5000 volts to replace existing nonshielded conductors, on existing equipment in industrial establishments only, under the following conditions:

(a) Where the condition of maintenance and supervision ensures that only qualified personnel install and service the installation.

(b) Conductors shall have insulation resistant to electric discharge and surface tracking, or the insulated conductor(s) shall be covered with a material resistant to ozone, electric discharge, and surface tracking.

(c) Where used in wet locations, the insulated conductor(s) shall have an overall nonmetallic jacket or a continuous metallic sheath.

(d) Insulation and jacket thicknesses shall be in accordance with Table 311.10(B).

Informational Note: Relocation or replacement of equipment may not comply with the term existing as related to this exception.

Exception No. 3: Where permitted in 311.36, Exception No. 2.

Part IV Ampacities

311.60 Conductors Rated 2001 to 35,000 Volts.

(A) Ampacities of Conductors Rated 2001 to 35,000 Volts. Ampacities for solid dielectric-insulated conductors shall be permitted to be determined by tables or under engineering supervision, as provided in 311.60(B) and (C).

The ampacity of Type MV cable installed in cable tray shall be determined in accordance with 392.80(B).

(1) Selection of Ampacity. Where more than one calculated or tabulated ampacity could apply for a given circuit length, the lowest value shall be used.

Exception: Where two different ampacities apply to adjacent portions of a circuit, the higher ampacity shall be permitted to be used beyond the point of transition, a distance equal to 3.0 m (10 ft) or 10 percent of the circuit length calculated at the higher ampacity, whichever is less.

Informational Note: See 110.40 for conductor temperature limitations due to termination provisions.

(B) Engineering Supervision. Under engineering supervision, conductor ampacities shall be permitted to be calculated by using the following general equation:

INSERT --> **[311.60(B)]**

where:

Tc = conductor temperature (°C)

Ta = ambient temperature (°C)

ΔTd = dielectric loss temperature rise

Rdc = dc resistance of conductor at temperature Tc

Yc = component ac resistance resulting from skin effect and proximity effect

Rca = effective thermal resistance between conductor and surrounding ambient

Informational Note: The dielectric loss temperature rise (ΔTd) is negligible for single circuit extruded dielectric cables rated below 46 kV.

(C) Tables. Ampacities for conductors rated 2001 to 35,000 volts shall be as specified in Table 311.60(C)(67) through Table 311.60(C)(86). Ampacities for ambient temperatures other than those specified in the ampacity tables shall be corrected in accordance with 311.60(D)(4).

Informational Note No. 1: For ampacities calculated in accordance with 311.60(A), reference IEEE 835-1994, Standard Power Cable Ampacity Tables, and the references therein for availability of all factors and constants.

Informational Note No. 2: Ampacities provided by this section do not take voltage drop into consideration. See 210.19(A), Informational Note No. 4, for branch circuits and 215.2(A), Informational Note No. 2, for feeders.

(D) Ampacity Adjustment

(1) Grounded Shields. Ampacities shown in Table 311.60(C)(69), Table 311.60(C)(70), Table 311.60(C)(81), and Table 311.60(C)(82) shall apply for cables with shields grounded at one point only. Where shields for these cables are grounded at more than one point, ampacities shall be adjusted to take into consideration the heating due to shield currents.

Informational Note: Tables other than those listed contain the ampacity of cables with shields grounded at multiple points.

(2) Burial Depth. Where the burial depth of direct burial or electrical duct bank circuits is modified from the values shown in a figure or table, ampacities shall be permitted to be modified as indicated in (B)(2)(a) and (B)(2)(b). No ampacity adjustments shall be required where the burial depth is decreased.

(a) Where burial depths are increased in part(s) of an electrical duct run, a decrease in ampacity of the conductors shall not be required, provided the total length of parts of the duct run increased in depth is less than 25 percent of the total run length.

(b) Where burial depths are deeper than shown in a specific underground ampacity table or figure, an ampacity derating factor of 6 percent per 300 mm (1 ft) increase in depth for all values of rho shall be permitted.

(3) Electrical Ducts Entering Equipment Enclosures. At locations where electrical ducts enter equipment enclosures from underground, spacing between such ducts, as shown in Figure 311.60(F)(6), shall be permitted to be reduced without requiring the ampacity of conductors therein to be reduced.

(4) Ambient Temperature Correction. Ampacities for ambient temperatures other than those specified in the ampacity tables shall be corrected in accordance with Table 311.60(D)(4) or shall be permitted to be calculated using the following equation:

INSERT --> [311.60(D)(4)]

where:

I′ = ampacity corrected for ambient temperature

I = ampacity shown in the table for Tc and Ta

Tc = temperature rating of conductor (°C)

Ta′ = new ambient temperature (°C)

Ta = ambient temperature used in the table (°C)

INSERT --> Table 311.60(D)(4) Ambient Temperature Correction Factors

(E) Ampacity in Air. Ampacities for conductors and cables rated 2001 to 35,000 volts in air shall be as specified in Table 311.60(C)(67) through Table 311.60(C)(76). Ampacities are based the following:

(1) Conductor Temperatures of 90°C (194°F) and 105°C (221°F)

(2) Ambient Air Temperature of 40°C (104°F)

Informational Note: See 311.60(D)(4) where the ambient air temperature is other than 40°C (104°F).

(F) Ampacity in Underground Electrical Ducts and Direct Buried in Earth. Ampacities for conductors and cables rated 2001 to 35,000 volts in underground electrical ducts and direct buried in earth shall be as specified in Table 311.60(C)(78) through Table 311.60(C)(86). Ampacities are based on the following:

(1) Ambient Earth Temperature of 20°C (68°F)

(2) Arrangement per Figure 310.60(C)(3)

(3) 100 Percent Load Factor

(4) Thermal Resistance (RHO) of 90

(5) Conductor Temperatures 90°C (194°F) and 105°C (221°F)

(6) Arrangement in accordance with Figure 310.60(F)(6)

(7) Minimum burial depths to the top electrical ducts or cables shall be in accordance with 300.50.

(8) Maximum depth to the top of electrical duct banks shall be 750 mm (30 in.) and maximum depth to the top of direct-buried cables shall be 900 mm (36 in.).

INSERT --> Table 311.60(C)(67) Ampacities of Insulated Single Copper Conductor Cables Triplexed in Air *Thru* Table 311.60(C)(86) Ampacities of Three Triplexed Single Insulated Aluminum Conductors Directly Buried in Earth

INSERT --> FIGURE 311.60(F)(6) Cable Installation Dimensions

Supplemental Information

File Name	Description	Approved
NEC-Article_311_Medium_Voltage_Cable.docx	New Article 311	✓
NEC_Article_310_Reorganized_and_Revised.docx	Revised and Reorganized Article 310	✓

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jan 11 23:37:26 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Article 311 Substantiation:

In order to consolidate the medium voltage requirements found in Articles 310 and 328, and to improve the usability of the code, the requirements are being combined into a new article 311.

Article 310 Substantiation:

These requirements Article 328 were moved to new Article 311.

The article is reorganized to increase the usability of the article. The ampacity requirements over the years have become increasingly difficult to use making Article 310 more difficult to use.

This reorganization includes moving the MV Cable requirements into a new article which also includes moving the requirements out of Article 328. Text was moved for clarity with redundant text deleted.

New types, first recognized in the 2017 NEC, XHHN, XHWN and XHWN-2 were added to the list of acceptable wire types for dry and damp locations.

New types, first recognized in the 2017 NEC, XHWN and XHWN-2 were added to the list of acceptable wire types for wet locations.

New text allows for the interpolation of ampacities for sizes not found in the ampacity tables under engineering supervision. Informational note was added to use conductor areas in Chapter 9 Table 8. DLO is not a recognized wiring method within the NEC, and therefore will not be added to any ampacity table.

For clarity, added Informational note that ampacity for cords are found in 400.5. Also added note for fixture wire ampacities in 402.5

Provide clarity to the user by removing the term allowable from allowable ampacities based on work done by the Ampacity Task Group.

Clarified that raceways and cables are not required to be installed a minimum distance above a roof.

Corrected reference in exception.

310.15(B)(3)(a)(4)a through c (NEC 2017)

Added XHHN and XHWN, XHWN-2 to ampacity tables based on appropriate temperature rating.

Replaced ampacity with ampere which is the appropriate term to correspond with 240.6(A). Also added “for fuses and inverse time circuit breakers” to provide additional guidance to user.

Added Dwelling Table from Annex D, Example D7 and Note that table shall be permitted if there are no temperature correction or adjustment factors.

Changed column heading from “Trade Name” to “Trade Designation” to more accurately describe the column. Trade designation was used because not all types are insulation.

Added XHWN and XHHN to list of conductor types and requirement that copper-clad aluminum conductors shall use AA-8000 series aluminum. Construction requirements for copper-clad aluminum were moved from the definition in Article 100. The definition that will remain in Article 100 includes metallurgically bonded. Markings are provided for insulated conductors and cable wiring methods and not for the conductor metal. The marking MB is unnecessary since the construction requirements in this code require all copper-clad conductors to be metallurgically bonded.

The revised wording now includes all types of grounding and bonding conductors in 310.6(C).

Article 328 Substantiation:

Relocate Article 328 into Article 311 to improve the usability of the code.

Response Message:

Public Input No. 459-NFPA 70-2017 [Section No. 310.60(A)(1)]

Public Input No. 1308-NFPA 70-2017 [New Section after 310.15(A)(2)]

Public Input No. 800-NFPA 70-2017 [Section No. 310.60(C)(4)]

Public Input No. 3085-NFPA 70-2017 [Section No. 310.15(B) [Excluding any Sub-Sections]]

Public Input No. 3087-NFPA 70-2017 [Section No. 310.10(C)]

Public Input No. 3529-NFPA 70-2017 [Section No. 310.15(B)(7)]

Public Input No. 3093-NFPA 70-2017 [Section No. 310.106(B)]

Public Input No. 3202-NFPA 70-2017 [Global Input]

Public Input No. 931-NFPA 70-2017 [Section No. 310.15(B) [Excluding any Sub-Sections]]

Public Input No. 1788-NFPA 70-2017 [Section No. 310.15(B)(7)]

Public Input No. 520-NFPA 70-2017 [Section No. 310.15(B)(7) Single...]

Public Input No. 932-NFPA 70-2017 [Section No. 310.15(B)(3)]

Public Input No. 3088-NFPA 70-2017 [Section No. 310.15(B)(3)]

Public Input No. 2122-NFPA 70-2017 [Section No. 310.106(B)]

Public Input No. 2439-NFPA 70-2017 [Section No. 310.15(A)(1)]

Public Input No. 2185-NFPA 70-2017 [Section No. 328.2]

Public Input No. 2750-NFPA 70-2017 [Section No. 310.15(B)(3)]

Public Input No. 3086-NFPA 70-2017 [Section No. 310.10(B)]

Public Input No. 2628-NFPA 70-2017 [Global Input]

Public Input No. 2646-NFPA 70-2017 [Section No. 310.104]

Public Input No. 1742-NFPA 70-2017 [Section No. 310.15(B)(3)]

Public Input No. 3340-NFPA 70-2017 [Section No. 310.110(C)]

Public Input No. 950-NFPA 70-2017 [Section No. 310.15(B)(7)]

Public Input No. 822-NFPA 70-2017 [Section No. 310.60(C)]

Public Input No. 559-NFPA 70-2017 [Section No. 310.15(B)(7) Single...]

Public Input No. 4290-NFPA 70-2017 [New Section after 310.15(C)]

Public Input No. 2945-NFPA 70-2017 [Section No. 310.15(B)(7)]

Public Input No. 2633-NFPA 70-2017 [Article 328]

Public Input No. 2510-NFPA 70-2017 [Section No. 310.104]

Public Input No. 2650-NFPA 70-2017 [Section No. 328.14]

Public Input No. 626-NFPA 70-2017 [Section No. 310.15(B)]

Public Input No. 3476-NFPA 70-2017 [Section No. 310.110(B)]

Public Input No. 930-NFPA 70-2017 [Section No. 310.15(A)(3)]

Public Input No. 3095-NFPA 70-2017 [Section No. 310.106(C)]

Editorial Comment

Click here

Article 311 Medium Voltage Conductors and Cable

Part I. General

311.1 Scope. [moved from 328.1]

This article covers the use, installation, ~~and~~ construction specifications and ampacities for medium voltage conductors and cable, Type MV. 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.

311.2 Definitions.

The definitions in this section shall apply within this article and throughout the code.

Medium Voltage Cable, Type MV. **[moved from 328.2]**

A single or multiconductor solid dielectric insulated cable rated 2001 volts up to and including 35,000 volts, nominal~~or higher~~.

Electrical Ducts. [moved from 310.2]

Electrical conduits, or other raceways round in cross section, that are suitable for use underground or embedded in concrete.

Thermal Resistivity. **[moved from 310.2]**

As used in this Code, the heat transfer capability through a substance by conduction.

Informational Note: Thermal resistivity is the reciprocal of thermal conductivity and is designated Rho, which is expressed in the units °C-cm/W.

311.6 Listing Requirements. [moved from 328.6]

Type MV cables and associated fittings shall be listed.

Part II. Construction Specifications [moved and reworked based on 310]

311.10 ~~Conductor~~ Constructions and Applications.

Type MV cables shall comply with the applicable provisions as follows:

(A) Conductor Application and Insulation.

Conductor ~~Application~~ application and ~~Insulation~~ insulation ~~Rated 2001 Volts and Higher~~ shall comply with Table 311.10(A).

Commented [BS1]: Any section with green is moved and this is how it will appear if all PI changes go through.

(B) Thickness of Insulation and Jacket for Nonshielded Insulated Conductors.

Thickness of ~~Insulation~~ insulation and ~~Jacket~~ jacket for ~~Nonshielded~~ nonshielded ~~Solid~~ solid ~~Dielectric~~ dielectric ~~Insulated~~ insulated ~~Conductors~~ conductors ~~Rated~~ rated 2001 volts to 5000 ~~Volts~~ volts shall comply with Table 311.10(B).

(C) Thickness of Insulation for Shielded Insulated Conductors.

Thickness of ~~Insulation~~ insulation for ~~Shielded~~ shielded ~~Solid~~ solid ~~Dielectric~~ dielectric ~~Insulated~~ insulated Cconductors ~~Rated~~ rated 2001 volts to 35,000 ~~Volts~~ volts shall comply with Table 311.10(C) ~~and the following:~~ and 311(C) (1) through (C)(3).

(1) 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 that 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.

(2) 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 in 100 percent insulation level applications where additional insulation is desirable.

(3) 173 Percent Insulation Level.

Cables in this category shall be permitted to be applied under all of the following conditions:

(1) In industrial establishments where the conditions of maintenance and supervision ensure that only qualified persons service the installation

(2) Where the fault clearing time requirements of the 133 percent level category cannot be met

(3) Where an orderly shutdown is essential to protect equipment and personnel

(4) Where t~~T~~here is adequate assurance that the faulted section will be de-energized in an orderly shutdown

Also, cables with this insulation thickness shall be permitted to be used in 100 or 133 percent insulation level applications where additional insulation strength is desirable.

INSERT --> Table 311.10(A) Conductor Application and Insulation Rated 2001 Volts and Higher

Trade Name	Type Letter	Maximum Operating Temperature	Application Provision	Insulation	Outer Covering
Medium voltage solid dielectric	MV-90	90°C	Dry or wet locations	Thermoplastic or thermosetting	Jacket, sheath, or armor
	MV-105*	105°C			

*Where design conditions require maximum conductor temperatures above 90°C.

INSERT --> Table 311.10(B) Thickness of Insulation and Jacket for Nonshielded Solid Dielectric Insulated Conductors Rated 2001 Volts to 5000 Volts

Conductor Size (AWG or kcmil)	Dry Locations, Single Conductor						Wet or Dry Locations					
	Without Jacket Insulation		With Jacket				Single Conductor				Multiconductor Insulation*	
			Insulation		Jacket		Insulation		Jacket			
	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils
8	2.79	110	2.29	90	0.76	30	3.18	125	2.03	80	2.29	90
6	2.79	110	2.29	90	0.76	30	3.18	125	2.03	80	2.29	90
4–2	2.79	110	2.29	90	1.14	45	3.18	125	2.03	80	2.29	90
1–2/0	2.79	110	2.29	90	1.14	45	3.18	125	2.03	80	2.29	90
3/0–4/0	2.79	110	2.29	90	1.65	65	3.18	125	2.41	95	2.29	90
213–500	3.05	120	2.29	90	1.65	65	3.56	140	2.79	110	2.29	90
501–750	3.30	130	2.29	90	1.65	65	3.94	155	3.18	125	2.29	90
751–1000	3.30	130	2.29	90	1.65	65	3.94	155	3.18	125	2.29	90
1001–1250	3.56	140	2.92	115	1.65	65	4.32	170	3.56	140	2.92	115
1251–1500	3.56	140	2.92	115	2.03	80	4.32	170	3.56	140	2.92	115
1501–2000	3.56	140	2.92	115	2.03	80	4.32	170	3.94	155	3.56	140

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

INSERT --> Table 311.10(C) Thickness of Insulation for Shielded Solid Dielectric Insulated Conductors Rated 2001 Volts to 35,000 Volts

Conductor Size (AWG or kcmil)	2001–5000 Volts		5001–8000 Volts						8001–15,000 Volts						15,001–25,000 Volts					
	100 Percent Insulation Level[1]		100 Percent Insulation Level		133 Percent Insulation Level[2]		173 Percent Insulation Level[3]		100 Percent Insulation Level[1]		133 Percent Insulation Level[2]		173 Percent Insulation Level[3]		100 Percent Insulation Level[1]		133 Percent Insulation Level[2]		173 Percent Insulation Level[3]	
	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils
8	2.29	90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6–4	2.29	90	2.92	115	3.56	140	4.45	175	—	—	—	—	—	—	—	—	—	—	—	—
2	2.29	90	2.92	115	3.56	140	4.45	175	4.45	175	5.59	220	6.60	260	—	—	—	—	—	—
1	2.29	90	2.92	115	3.56	140	4.45	175	4.45	175	5.59	220	6.60	260	6.60	260	8.13	320	10.67	420
1/0–2000	2.29	90	2.92	115	3.56	140	4.45	175	4.45	175	5.59	220	6.60	260	6.60	260	8.13	320	10.67	420

Conductor Size (AWG or kcmil)	25,001–28,000 Volts						28,001–35,000 Volts					
	100 Percent Insulation Level[1]		133 Percent Insulation Level[2]		173 Percent Insulation Level[3]		100 Percent Insulation Level[1]		133 Percent Insulation Level[2]		173 Percent Insulation Level[3]	
	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils	mm	mils
1	7.11	280	8.76	345	11.30	445	—	—	—	—	—	—
1/0–2000	7.11	280	8.76	345	11.30	445	8.76	345	10.67	420	14.73	580

311.12 Conductors. [is taken from 310.106, but also moving to 310.3]

(A) Minimum Size of Conductors.

The minimum size of conductors shall be as shown in Table 311.12(A), except as permitted elsewhere in this Code.

INSERT --> Table 311.12(A) Minimum Size of Conductors

Table ~~310.106~~311.12(A) Minimum Size of Conductors

Conductor Voltage Rating (Volts)	Minimum Conductor Size (AWG)	
	Copper,	Aluminum, or Copper-Clad Aluminum
~~0–2000~~	~~14~~	~~12~~
2001–5000	8	~~8~~
5001–8000	6	~~6~~

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Conductor Voltage Rating (Volts)	Minimum Conductor Size (AWG)	
	Copper,	Aluminum, or Copper-Clad Aluminum
8001–15,000	2	~~2~~
15,001–28,000	1	~~1~~
28,001–35,000	1/0	~~1/0~~

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(B) Conductor Material.

Conductors shall be of aluminum, copper-clad aluminum, or copper unless otherwise specified.

(C) Stranded Conductors.

Where installed in raceways, conductors not specifically permitted or required elsewhere in this Code to be solid, shall be stranded.

311.14 Conductor Identification. [text only from 310.110(C)]

Conductors that are intended for use as ungrounded conductors, whether used as a single conductor or in multiconductor cables, shall be finished to be clearly distinguishable from grounded and grounding conductors. Distinguishing markings shall not conflict in any manner with the surface markings required by 311.16(B)(1). Branch-circuit ungrounded conductors shall be identified in accordance with 210.5(C). Feeders shall be identified in accordance with 215.12.

311.16 Marking. [is taken from 310.120, but also moving to 310.8]

(A) Required Information.

All conductors and cables shall be marked to indicate the following information, using the applicable method described in 311.16(B):

(1) The maximum rated voltage.

(2) The proper type letter or letters for the type of wire or cable as specified elsewhere in this Code.

(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.

Informational Note: See ~~Conductor Properties~~, Table 8 of Chapter 9, Conductor Properties, for conductor area expressed in SI units for conductor sizes specified in AWG or circular mil area.

~~(5) Cable assemblies where the neutral conductor is smaller than the ungrounded conductors shall be so marked.~~

(B) Method of Marking.

One or more of the following methods shall be used for marking of cable:

(1) Surface Marking.

~~The following conductors and c~~Cables shall be durably marked on the surface. The AWG size or circular mil area shall be repeated at intervals not exceeding 610 mm (24 in.). All other markings shall be repeated at intervals not exceeding 1.0 m (40 in.).

~~(1) Single-conductor and multiconductor rubber and thermoplastic-insulated wire and cable~~

~~(2) Nonmetallic-sheathed cable~~

~~(3) Service-entrance cable~~

~~(4) Underground feeder and branch-circuit cable~~

~~(5) Tray cable~~

~~(6) Irrigation cable~~

~~(7) Power-limited tray cable~~

~~(8) Instrumentation tray cable~~

(2) Marker Tape.

Metal-covered multiconductor cables shall employ a marker tape located within the cable and ~~running for~~along its complete length.

~~*Exception No. 1: Type MI cable.*~~
~~*Exception No. 2: Type AC cable.*~~
~~*Exception No. 3: The information required in 310.120(A) shall be permitted to be durably marked on the outer nonmetallic covering of Type MC, Type ITC, or Type PLTC cables at intervals not exceeding 1.0 m (40 in.).*~~
~~*Exception No. 4: The information required in 310.120(A) shall be permitted to be durably marked on a nonmetallic covering under the metallic sheath of Type ITC or Type PLTC cable at intervals not exceeding 1.0 m (40 in.).*~~
~~Informational Note: Included in the group of metal-covered cables are Type AC cable (Article 320), Type MC cable (Article 330), and lead-sheathed cable.~~

(3) Tag Marking.

Metal-covered, single-conductor cables shall be marked by means of a printed tag attached to the reel.~~The following conductors and cables shall be marked by means of a printed tag attached to the coil, reel, or carton:~~

~~(1) Type MI cable~~

~~(2) Switchboard wires~~

~~(3) Metal-covered, single-conductor cables~~

~~(4) Type AC cable~~

(4) Optional Marking of Wire Size.

The information required in ~~310~~311.~~12~~016(A)(4) shall be permitted to be marked on the surface of the individual insulated conductors for ~~the following~~ multiconductor Type MC cable~~s~~:.

~~(1) Type MC cable~~

~~(2) Tray cable~~

~~(3) Irrigation cable~~

~~(4) Power-limited tray cable~~

~~(5) Power-limited fire alarm cable~~

~~(6) Instrumentation tray cable~~

~~**(C) Suffixes to Designate Number of Conductors.**~~
~~A type letter or letters used alone shall indicate a single insulated conductor. The letter suffixes shall be indicated as follows:~~

~~(1) D — For two insulated conductors laid parallel within an outer nonmetallic covering~~

~~(2) M — For an assembly of two or more insulated conductors twisted spirally within an outer nonmetallic covering~~

(~~D~~C) Optional Markings.

Cables shall be permitted ~~All conductors and cables contained in Chapter 3 shall be permitted~~ to be ~~surface~~ marked to indicate special characteristics of the cable materials. These markings include, but are not limited to, markings for limited smoke, sunlight resistant, and so forth.

Part III. Installation

311.30 Installation. [moved from 328.14]

Type MV cable shall be installed, terminated, and tested by qualified persons.

Informational Note No. 1: Information about accepted industry practices and installation procedures for medium-voltage cable are described in ANSI/NECA/NCSCB 600~~-2014~~, Standard for Installing and Maintaining Medium-Voltage Cable and in IEEE 576~~-2000~~, Recommended Practice for Installation, Termination, and Testing of Insulated Power Cables as Used in Industrial and Commercial Applications

Informational Note No.2: Where medium-voltage cable is used for direct-current (dc) circuits, low frequency polarization can create hazardous voltages. When handling the cable these voltages may be present or may develop on dc stressed cable while the circuit is energized. Solidly grounding the cable prior to contacting, cutting or disconnecting cables in dc circuits is a method to discharge these voltages.

311.32 Uses Permitted. [moved from 328.10]

Type MV cable shall be permitted for use on power systems rated up to and including 35,000 volts, nominal, as follows:

(1) In wet or dry locations.

(2) In raceways.

(3) In cable trays, where identified for the use, in accordance with 392.10, 392.20(B), (C), and (D), 392.22(C), 392.30(B)(1), 392.46, 392.56, and 392.60. Type MV cable that has an overall metallic sheath or armor, complies with the requirements for Type MC cable, and is identified as "MV or MC" shall be permitted to be installed in cable trays in accordance with 392.10(B)(2).

~~(4) Direct buried in accordance with 300.50.~~

(4) In messenger-supported wiring in accordance with Part II of Article 396.

(5) As exposed runs in accordance with 300.37. Type MV cable that has an overall metallic sheath or armor, complies with the requirements for Type MC cable, and is identified as "MV or MC" shall be permitted to be installed as exposed runs of metal-clad cable in accordance with 300.37.

(6) Corrosive conditions where exposed to oils, greases, vapors, gases, fumes, liquids, or other substances having a deleterious effect on the conductor or insulation shall be of a type suitable for the application.

(7) Conductors in parallel in accordance with 310.10(H).

(8) Type MV Cable used where exposed to direct sunlight shall be identified for the use.

Informational Note: The "Uses Permitted" is not an all-inclusive list.

311.36 Direct-Burial Conductors. **[moved from 310.10(F), but also renumbered as 310.10(E)]**

Type MV cables ~~Conductors~~ used for direct burial applications shall be of a type identified for such use and installed in accordance with 300.50.

Cables rated above 2000 volts shall be shielded.

Exception No. 1: Nonshielded multiconductor cables rated 2001— volts to 2400 volts shall be permitted if the cable has an overall metallic sheath or armor.

The metallic shield, sheath, or armor shall be connected to ~~a~~ grounding electrode conductor, grounding busbar, or a grounding electrode.

Exception No. 2: Airfield lighting cable used in series circuits that are rated up to 5000 volts and are powered by regulators shall be permitted to be nonshielded.

Informational Note to Exception No. 2: Federal Aviation Administration (FAA) Advisory Circulars (ACs) provide additional practices and methods for airport lighting.

~~Informational Note No. 1: See 300.5 for installation requirements for conductors rated 1000 volts or less.~~
~~Informational Note No. 2: See 300.50 for installation requirements for conductors rated over 1000 volts.~~

311.40 Support. **[moved from 328.30]**

Type MV cable terminated in equipment or installed in pull boxes or vaults shall be secured and supported by metallic or nonmetallic supports suitable to withstand the weight by cable ties listed and identified for securement and support, or other approved means, at intervals not exceeding 1.5 m (5 ft) from terminations or a maximum of 1.8 m (6 ft) between supports.

311.44 Shielding. [moved from 310.10(E)]

Nonshielded, ozone-resistant insulated conductors with a maximum phase-to-phase voltage of 5000 volts shall be permitted in Type MC cables in industrial establishments where the conditions of maintenance and supervision ensure that only qualified persons service the installation. For other establishments, solid dielectric insulated conductors operated above 2000 volts in permanent installations shall have ozone resistant insulation and shall be shielded. All metallic insulation shields shall be connected to a grounding electrode conductor, a grounding busbar, an equipment grounding conductor, or a grounding electrode.

Informational Note: The primary purposes of shielding are to confine the voltage stresses to the insulation, dissipate insulation leakage current, drain off the capacitive charging current, and carry ground-fault current to facilitate operation of ground-fault protective devices in the event of an electrical cable fault.

Exception No. 1: Nonshielded insulated conductors listed by a qualified testing laboratory shall be permitted for use up to 2400 volts under the following conditions:

(a) Conductors shall have insulation resistant to electric discharge and surface tracking, or the insulated conductor(s) shall be covered with a material resistant to ozone, electric discharge, and surface tracking.

(b) Where used in wet locations, the insulated conductor(s) shall have an overall nonmetallic jacket or a continuous metallic sheath.

(c) Insulation and jacket thicknesses shall be in accordance with Table 311.10(B).

Exception No. 2: Nonshielded insulated conductors listed by a qualified testing laboratory shall be permitted for use up to 5000 volts to replace existing nonshielded conductors, on existing equipment in industrial establishments only, under the following conditions:

(a) Where the condition of maintenance and supervision ensures that only qualified personnel install and service the installation.

(b) Conductors shall have insulation resistant to electric discharge and surface tracking, or the insulated conductor(s) shall be covered with a material resistant to ozone, electric discharge, and surface tracking.

(c) Where used in wet locations, the insulated conductor(s) shall have an overall nonmetallic jacket or a continuous metallic sheath.

(d) Insulation and jacket thicknesses shall be in accordance with Table 311.10(B).

Informational Note: Relocation or replacement of equipment may not comply with the term existing as related to this exception.

Exception No. 3: Where permitted in 311.36, Exception No. 2.

Part IV Ampacities

311.60 Ampacities of Conductors.~~Conductors Rated 2001 to 35,000 Volts.~~

(A) General

(1) Tables or Engineering Supervision. ~~Ampacities of Conductors Rated 2001 to 35,000 Volts.~~

Ampacities for solid dielectric-insulated conductors shall be permitted to be determined by tables or under engineering supervision, as provided in 311.60(B) and (C).

The ampacity of Type MV cable installed in cable tray shall be determined in accordance with 392.80(B).

(~~1~~2) Selection of Ampacity.

Where more than one calculated or tabulated ampacity could apply for a given circuit length, the lowest value shall be used.

Exception: Where ~~two~~ different ampacities apply to ~~adjacent~~ portions of a circuit, the higher ampacity shall be permitted to be used ~~beyond the point of transition, a distance equal~~ if the total portion(s) of the circuit with the lower ampacity does not exceed the lesser of~~to~~ 3.0 m (10 ft) or 10 percent of the total circuit ~~length calculated at the higher ampacity, whichever is less~~.

Informational Note: See 110.40 for conductor temperature limitations due to termination provisions.

(B) Engineering Supervision.

Under engineering supervision, conductor ampacities shall be permitted to be calculated by using the following general equation:

INSERT --> **[311.60(B)]**

where:

Tc = conductor temperature (°C)

Ta = ambient temperature (°C)

ΔTd = dielectric loss temperature rise

Rdc = dc resistance of conductor at temperature Tc

Yc = component ac resistance resulting from skin effect and proximity effect

Rca = effective thermal resistance between conductor and surrounding ambient

Informational Note: The dielectric loss temperature rise (ΔTd) is negligible for single circuit extruded dielectric cables rated below 46 kV.

(C) Tables.

Ampacities for conductors rated 2001 volts to 35,000 volts shall be as specified in Table 311.60(C)(67) through Table 311.60(C)(86). Ampacities for ambient temperatures other than those specified in the ampacity tables shall be corrected in accordance with 311.60(D)(4).

Informational Note No. 1: For ampacities calculated in accordance with 311.60(A), reference IEEE 835-1994, Standard Power Cable Ampacity Tables, and the references therein for availability of all factors and constants.

Informational Note No. 2: Ampacities provided by this section do not take voltage drop into consideration. See 210.19(A), Informational Note No. 4, for branch circuits and 215.2(A), Informational Note No. 2, for feeders.

(D) Ampacity Adjustment.

(1) Grounded Shields. [moved out of (C)]

Ampacities shown in Table 311.60(C)(69), Table 311.60(C)(70), Table 311.60(C)(81), and Table 311.60(C)(82) shall apply for cables with shields grounded at one point only. Where shields for these cables are grounded at more than one point, ampacities shall be adjusted to take into consideration the heating due to shield currents.

Informational Note: Tables other than those listed contain the ampacity of cables with shields grounded at multiple points.

(2) Burial Depth ~~of Underground Circuits~~. [moved out of (C)]

Where the burial depth of direct burial or electrical duct bank circuits is modified from the values shown in a figure or table, ampacities shall be permitted to be modified as indicated in (B)(2)(a) and (B)(2)(b). No ampacity adjustments shall be required where the burial depth is decreased.

(a) Where burial depths are increased in part(s) of an electrical duct run, a decrease in ampacity of the conductors shall not be required, provided the total length of parts of the duct run increased in depth is less than 25 percent of the total run length.

(b) Where burial depths are deeper than shown in a specific underground ampacity table or figure, an ampacity derating factor of 6 percent per 300 mm (1 ft) increase in depth for all values of rho shall be permitted.

~~No ampacity adjustments shall be required where the burial depth is decreased.~~

(3) Electrical Ducts ~~in~~ Entering Equipment Enclosures~~Figure 310.60(C)(3)~~.

At locations where electrical ducts enter equipment enclosures from underground, spacing between such ducts, as shown in Figure 311.60(F)(6), shall be permitted to be reduced without requiring the ampacity of conductors therein to be reduced.

(4) Ambient Temperature Correction.

Ampacities for ambient temperatures other than those specified in the ampacity tables shall be corrected in accordance with Table 311.60(D)(4) or shall be permitted to be calculated using the following equation:

$$I' = I\sqrt{\frac{T_c - T_a'}{T_c - T_a}}$$ ~~INSERT ->~~ **[311.60(D)(4)]**

where:

I′ = ampacity corrected for ambient temperature

I = ampacity shown in the table for Tc and Ta

Tc = temperature rating of conductor (°C)

Ta′ = new ambient temperature (°C)

Ta = ambient temperature used in the table (°C)

INSERT --> **Table 311.60(D)(4) Ambient Temperature Correction Factors**

For ambient temperatures other than 40°C (104°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate factor shown below.			
Ambient Temperature (°C)	Temperature Rating of Conductor		Ambient Temperature (°F)
	90°C	105°C	
10 or less	1.26	1.21	50 or less
11–15	1.22	1.18	51–59
16–20	1.18	1.14	60–68
21–25	1.14	1.11	69–77
26–30	1.10	1.07	78–86
31–35	1.05	1.04	87–95
36–40	1.00	1.00	96–104
41–45	0.95	0.96	105–113
46–50	0.89	0.92	114–122
51–55	0.84	0.88	123–131
56–60	0.77	0.83	132–140
61–65	0.71	0.78	141–149
66–70	0.63	0.73	150–158
71–75	0.55	0.68	159–167
76–80	0.45	0.62	168–176
81–85	0.32	0.55	177–185
86–90	—	0.48	186–194
91–95	—	0.39	195–203
96–100	—	0.28	204–212

(E) Ampacity in Air.

Ampacities for conductors and cables ~~rated 2001 to 35,000 volts~~ in air shall be as specified in Table 311.60(C)(67) through Table 311.60(C)(76). Ampacities ~~are~~ shall be based on the following:

(1) Conductor ~~T~~temperatures of 90°C (194°F) and 105°C (221°F)

(2) Ambient ~~A~~air ~~T~~temperature of 40°C (104°F)

Informational Note: See 311.60(D)(4) where the ambient air temperature is other than 40°C (104°F).

(F) Ampacity in Underground Electrical Ducts and Direct Buried in Earth.

Ampacities for conductors and cables ~~rated 2001 to 35,000 volts~~ in underground electrical ducts and direct buried in earth shall be as specified in Table 311.60(C)(7~~8~~7) through Table 311.60(C)(86). Ampacities ~~are~~shall be based on the following:

(1) Ambient ~~E~~earth ~~T~~temperature of 20°C (68°F)

(2) Arrangement in accordance with~~per~~ Figure 31~~0~~1.60(~~C~~F)~~(3~~)

(3) 100 ~~P~~percent ~~L~~load ~~F~~factor

(4) Thermal ~~R~~resistance (RHO) of 90

(5) Conductor ~~T~~temperatures 90°C (194°F) and 105°C (221°F)

~~(6) Arrangement in accordance with Figure 310.60(F)(6)~~

(~~7~~6) Minimum burial depths to the top electrical ducts or cables shall be in accordance with 300.50.

(~~8~~7) Maximum depth to the top of electrical duct banks shall be 750 mm (30 in.) and maximum depth to the top of direct-buried cables shall be 900 mm (36 in.).

~~**INSERT ->**~~ **Table 311.60(C)(67) Ampacities of Insulated Single Copper Conductor Cables Triplexed in Air** ~~***Thru* Table 311.60(C)(86) Ampacities of Three Triplexed Single Insulated Aluminum Conductors Directly Buried in Earth~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	65	74	—	—
6	90	99	100	110
4	120	130	130	140
2	160	175	170	195
1	185	205	195	225
1/0	215	240	225	255
2/0	250	275	260	295
3/0	290	320	300	340
4/0	335	375	345	390
250	375	415	380	430

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
350	465	515	470	525
500	580	645	580	650
750	750	835	730	820
1000	880	980	850	950

Note: Refer to 311.60(~~D~~)(~~4~~E) for the ampacity, 311.10(A) for conductor maximum operating temperature and application, and 311.60(D)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).

Table 311.60(C)(68) Ampacities of Insulated Single Aluminum Conductor Cables Triplexed in Air ~~Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	50	57	—	—
6	70	77	75	84
4	90	100	100	110
2	125	135	130	150
1	145	160	150	175
1/0	170	185	175	200
2/0	195	215	200	230
3/0	225	250	230	265
4/0	265	290	270	305
250	295	325	300	335
350	365	405	370	415
500	460	510	460	515
750	600	665	590	660
1000	715	800	700	780

Informational Note: Refer to 311.60(E) for the ampacity, 311.10(A) for conductor maximum operating temperature and application, and 311.60(D)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).

~~Note: Refer to 311.60(D)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).~~

Table 311.60(C)(69) Ampacities of Insulated Single Copper Conductor Isolated in Air ~~Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~					
	2001–5000 Volts Ampacity		5001–15,000 Volts Ampacity		15,001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	83	93	—	—	—	—
6	110	120	110	125	—	—
4	145	160	150	165	—	—
2	190	215	195	215	—	—
1	225	250	225	250	225	250
1/0	260	290	260	290	260	290
2/0	300	330	300	335	300	330
3/0	345	385	345	385	345	380
4/0	400	445	400	445	395	445
250	445	495	445	495	440	490
350	550	615	550	610	545	605
500	695	775	685	765	680	755
750	900	1000	885	990	870	970
1000	1075	1200	1060	1185	1040	1160
1250	1230	1370	1210	1350	1185	1320
1500	1365	1525	1345	1500	1315	1465
1750	1495	1665	1470	1640	1430	1595
2000	1605	1790	1575	1755	1535	1710

Informational Note: Refer to 311.60(E) for the ampacity, 311.10(A) for conductor maximum operating temperature and application, and 311.60(D)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).

~~Note: Refer to 311.60(D)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).~~

Table 311.60(C)(70) Ampacities of Insulated Single Aluminum Conductor Isolated in Air ~~Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~					
	2001–5000 Volts Ampacity		5001–15,000 Volts Ampacity		15,001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	64	71	—	—	—	—
6	85	95	87	97	—	—
4	115	125	115	130	—	—
2	150	165	150	170	—	—
1	175	195	175	195	175	195
1/0	200	225	200	225	200	225
2/0	230	260	235	260	230	260
3/0	270	300	270	300	270	300
4/0	310	350	310	350	310	345

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~					
	2001–5000 Volts Ampacity		5001–15,000 Volts Ampacity		15,001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
250	345	385	345	385	345	380
350	430	480	430	480	430	475
500	545	605	535	600	530	590
750	710	790	700	780	685	765
1000	855	950	840	940	825	920
1250	980	1095	970	1080	950	1055
1500	1105	1230	1085	1215	1060	1180
1750	1215	1355	1195	1335	1165	1300
2000	1320	1475	1295	1445	1265	1410

Informational Note: Refer to 311.60(E) for the ampacity, 311.10(A) for conductor maximum operating temperature and application, and 311.60(D)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).

~~Note: Refer to 311.60(D)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).~~

Table 311.60(C)(71) Ampacities of an Insulated Three-Conductor Copper Cable Isolated in Air ~~Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	59	66	—	—
6	79	88	93	105
4	105	115	120	135
2	140	154	165	185
1	160	180	185	210
1/0	185	205	215	240
2/0	215	240	245	275
3/0	250	280	285	315
4/0	285	320	325	360
250	320	355	360	400
350	395	440	435	490
500	485	545	535	600
750	615	685	670	745
1000	705	790	770	860

Informational Note: Refer to 311.60(E) for the ampacity, 311.10(A) for conductor maximum operating temperature and application, and 311.60(D)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).

~~Note: Refer to 311.60(D)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).~~

Table 311.60(C)(72) Ampacities of an Insulated Three-Conductor Aluminum Cable Isolated in ~~Air Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	46	51	—	—
6	61	68	72	80
4	81	90	95	105
2	110	120	125	145
1	125	140	145	165
1/0	145	160	170	185
2/0	170	185	190	215
3/0	195	215	220	245
4/0	225	250	255	285
250	250	280	280	315
350	310	345	345	385
500	385	430	425	475
750	495	550	540	600
1000	585	650	635	705

Informational Note: Refer to 311.60(E) for the ampacity, 311.10(A) for conductor maximum operating temperature and application, and 311.60(D)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).

~~Note: Refer to 311.60(C)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).~~

Table 311.60(C)(73) Ampacities of an Insulated Triplexed or Three Single-Conductor Copper Cables in Isolated Conduit in Air ~~Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	55	61	—	—
6	75	84	83	93
4	97	110	110	120
2	130	145	150	165
1	155	175	170	190
1/0	180	200	195	215
2/0	205	225	225	255
3/0	240	270	260	290
4/0	280	305	295	330
250	315	355	330	365
350	385	430	395	440
500	475	530	480	535

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
750	600	665	585	655
1000	690	770	675	755

Informational Note: Refer to 311.60(E) for the ampacity, 311.10(A) for conductor maximum operating temperature and application, and 311.60(D)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).

~~Note: Refer to 311.60(C)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).~~

Table 311.60(C)(74) Ampacities of an Insulated Triplexed or Three Single-Conductor Aluminum Cables in Isolated Conduit in Air ~~Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	43	48	—	—
6	58	65	65	72
4	76	85	84	94
2	100	115	115	130
1	120	135	130	150
1/0	140	155	150	170
2/0	160	175	175	200
3/0	190	210	200	225
4/0	215	240	230	260
250	250	280	255	290
350	305	340	310	350
500	380	425	385	430
750	490	545	485	540
1000	580	645	565	640

Informational Note: Refer to 311.60(E) for the ampacity, 311.10(A) for conductor maximum operating temperature and application, and 311.60(D)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).

~~Note: Refer to 311.60(C)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).~~

Table 311.60(C)(75) Ampacities of an Insulated Three-Conductor Copper Cable in Isolated Conduit in Air ~~Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	52	58	—	—
6	69	77	83	92
4	91	100	105	120

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
2	125	135	145	165
1	140	155	165	185
1/0	165	185	195	215
2/0	190	210	220	245
3/0	220	245	250	280
4/0	255	285	290	320
250	280	315	315	350
350	350	390	385	430
500	425	475	470	525
750	525	585	570	635
1000	590	660	650	725

Informational Note: Refer to 311.60(E) for the ampacity, 311.10(A) for conductor maximum operating temperature and application, and 311.60(D)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).

~~Note: Refer to 311.60(C)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).~~

Table 311.60(C)(76) Ampacities of an Insulated Three-Conductor Aluminum Cable in Isolated Conduit in Air ~~Based on Conductor Temperatures of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
8	41	46	—	—
6	53	59	64	71
4	71	79	84	94
2	96	105	115	125
1	110	125	130	145
1/0	130	145	150	170
2/0	150	165	170	190
3/0	170	190	195	220
4/0	200	225	225	255
250	220	245	250	280
350	275	305	305	340
500	340	380	380	425
750	430	480	470	520
1000	505	560	550	615

Informational Note: Refer to 311.60(E) for the ampacity, 311.10(A) for conductor maximum operating temperature and application, and 311.60(D)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).

~~Note: Refer to 311.60(C)(4) for the ampacity correction factors where the ambient air temperature is other than 40°C (104°F).~~

Table 311.60(C)(77) Ampacities of Three Single-Insulated Copper Conductors in Underground Electrical Ducts (Three Conductors per Electrical Duct) ~~Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement in Accordance with Figure 311.60(C)(3), 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures of 90°C (194°F) and 105°C (221°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit [See Figure 311.60(F), Detail 1.]				
8	64	69	—	—
6	85	92	90	97
4	110	120	115	125
2	145	155	155	165
1	170	180	175	185
1/0	195	210	200	215
2/0	220	235	230	245
3/0	250	270	260	275
4/0	290	310	295	315
250	320	345	325	345
350	385	415	390	415
500	470	505	465	500
750	585	630	565	610
1000	670	720	640	690
Three Circuits [See Figure 311.60(~~C~~)(~~3~~E), Detail 2.]				
8	56	60	—	—
6	73	79	77	83
4	95	100	99	105
2	125	130	130	135
1	140	150	145	155
1/0	160	175	165	175
2/0	185	195	185	200
3/0	210	225	210	225
4/0	235	255	240	255
250	260	280	260	280
350	315	335	310	330
500	375	405	370	395
750	460	495	440	475
1000	525	565	495	535
Six Circuits [See Figure 311.60(~~C~~)(~~3~~E), Detail 3.]				
8	48	52	—	—

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
6	62	67	64	68
4	80	86	82	88
2	105	110	105	115
1	115	125	120	125
1/0	135	145	135	145
2/0	150	160	150	165
3/0	170	185	170	185
4/0	195	210	190	205
250	210	225	210	225
350	250	270	245	265
500	300	325	290	310
750	365	395	350	375
1000	410	445	390	415

Informational Note: Refer to 311.60(F) for basis of ampacities and table 311.10(A) for the temperature rating of the conductor.

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Table 311.60(C)(78) Ampacities of Three Single-Insulated Aluminum Conductors in Underground Electrical Ducts (Three Conductors per Electrical Duct) ~~**Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement in Accordance with Figure 311.60(C)(3), 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures of 90°C (194°F) and 105°C (221°F)**~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit [See Figure 311.60(~~C)(3~~E), Detail 1.]				
8	50	54	—	—
6	66	71	70	75
4	86	93	91	98
2	115	125	120	130
1	130	140	135	145
1/0	150	160	155	165
2/0	170	185	175	190
3/0	195	210	200	215
4/0	225	245	230	245
250	250	270	250	270
350	305	325	305	330
500	370	400	370	400
750	470	505	455	490
1000	545	590	525	565

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
Three Circuits [See Figure 311.60(~~C~~)(~~3~~F), Detail 2.]				
8	44	47	—	—
6	57	61	60	65
4	74	80	77	83
2	96	105	100	105
1	110	120	110	120
1/0	125	135	125	140
2/0	145	155	145	155
3/0	160	175	165	175
4/0	185	200	185	200
250	205	220	200	220
350	245	265	245	260
500	295	320	290	315
750	370	395	355	385
1000	425	460	405	440
Six Circuits [See Figure 311.60(~~C~~)(~~3~~F), Detail 3.]				
8	38	41	—	—
6	48	52	50	54
4	62	67	64	69
2	80	86	80	88
1	91	98	90	99
1/0	105	110	105	110
2/0	115	125	115	125
3/0	135	145	130	145
4/0	150	165	150	160
250	165	180	165	175
350	195	210	195	210
500	240	255	230	250
750	290	315	280	305
1000	335	360	320	345

Informational Note: Refer to 311.60(F) for basis of ampacities and table 311.10(A) for the temperature rating of the conductor.

Table 311.60(C)(79) Ampacities of Three Insulated Copper Conductors Cabled Within an Overall Covering (Three-Conductor Cable) in Underground Electrical Ducts (One Cable per Electrical Duct)
~~Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement in Accordance with Figure 311.60(C)(3), 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures of 90°C (194°F) and 105°C (221°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit [See Figure 311.60(~~C~~)(3E), Detail 1.]				
8	59	64	—	—
6	78	84	88	95
4	100	110	115	125
2	135	145	150	160
1	155	165	170	185
1/0	175	190	195	210
2/0	200	220	220	235
3/0	230	250	250	270
4/0	265	285	285	305
250	290	315	310	335
350	355	380	375	400
500	430	460	450	485
750	530	570	545	585
1000	600	645	615	660
Three Circuits [See Figure 311.60(~~C~~)(3E), Detail 2.]				
8	53	57	—	—
6	69	74	75	81
4	89	96	97	105
2	115	125	125	135
1	135	145	140	155
1/0	150	165	160	175
2/0	170	185	185	195
3/0	195	210	205	220
4/0	225	240	230	250
250	245	265	255	270
350	295	315	305	325
500	355	380	360	385
750	430	465	430	465
1000	485	520	485	515
Six Circuits [See Figure 311.60(~~C~~)(3E), Detail 3.]				
8	46	50	—	—
6	60	65	63	68
4	77	83	81	87
2	98	105	105	110

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
1	110	120	115	125
1/0	125	135	130	145
2/0	145	155	150	160
3/0	165	175	170	180
4/0	185	200	190	200
250	200	220	205	220
350	240	270	245	275
500	290	310	290	305
750	350	375	340	365
1000	390	420	380	405

Informational Note: Refer to 311.60(F) for basis of ampacities and table 311.10(A) for the temperature rating of the conductor.

Table 311.60(C)(80) Ampacities of Three Insulated Aluminum Conductors Cabled Within an Overall Covering (Three-Conductor Cable) in Underground Electrical Ducts (One Cable per Electrical Duct)
~~Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement in Accordance with Figure 311.60(C)(3), 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures of 90°C (194°F) and 105°C (221°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit [See Figure 311.60(~~C)(3~~F), Detail 1.]				
8	46	50	—	—
6	61	66	69	74
4	80	86	89	96
2	105	110	115	125
1	120	130	135	145
1/0	140	150	150	165
2/0	160	170	170	185
3/0	180	195	195	210
4/0	205	220	220	240
250	230	245	245	265
350	280	310	295	315
500	340	365	355	385
750	425	460	440	475
1000	495	535	510	545

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
Three Circuits [See Figure 311.60(~~C~~)(~~3~~E), Detail 2.]				
8	41	44	—	—
6	54	58	59	64
4	70	75	75	81
2	90	97	100	105
1	105	110	110	120
1/0	120	125	125	135
2/0	135	145	140	155
3/0	155	165	160	175
4/0	175	185	180	195
250	190	205	200	215
350	230	250	240	255
500	280	300	285	305
750	345	375	350	375
1000	400	430	400	430
Six Circuits [See Figure 311.60(~~C~~)(~~3~~E), Detail 3.]				
8	36	39	—	—
6	46	50	49	53
4	60	65	63	68
2	77	83	80	86
1	87	94	90	98
1/0	99	105	105	110
2/0	110	120	115	125
3/0	130	140	130	140
4/0	145	155	150	160
250	160	170	160	170
350	190	205	190	205
500	230	245	230	245
750	280	305	275	295
1000	320	345	315	335

Informational Note: Refer to 311.60(F) for basis of ampacities and table 311.10(A) for the temperature rating of the conductor.

Table 311.60(C)(81) Ampacities of Single Insulated Copper Conductors Directly Buried in Earth ~~Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure 311.60(C)(3), 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures of 90°C (194°F) and 105°C (221°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit, Three Conductors [See Figure 311.60(~~C~~)(~~3~~E), Detail 9.]				
8	110	115	—	—
6	140	150	130	140
4	180	195	170	180
2	230	250	210	225
1	260	280	240	260
1/0	295	320	275	295
2/0	335	365	310	335
3/0	385	415	355	380
4/0	435	465	405	435
250	470	510	440	475
350	570	615	535	575
500	690	745	650	700
750	845	910	805	865
1000	980	1055	930	1005
Two Circuits, Six Conductors [See Figure 311.60(~~C~~)(~~3~~E), Detail 10.]				
8	100	110	—	—
6	130	140	120	130
4	165	180	160	170
2	215	230	195	210
1	240	260	225	240
1/0	275	295	255	275
2/0	310	335	290	315
3/0	355	380	330	355
4/0	400	430	375	405
250	435	470	410	440
350	520	560	495	530
500	630	680	600	645
750	775	835	740	795
1000	890	960	855	920

Informational Note: Refer to 311.60(F) for basis of ampacities and table 311.10(A) for the temperature rating of the conductor.

Table 311.60(C)(82) Ampacities of Single Insulated Aluminum Conductors Directly Buried in Earth ~~Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure 311.60(C)(3), 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures of 90°C (194°F) and 105°C (221°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit, Three Conductors [See Figure 311.60(~~C~~)(~~3~~F), Detail 9.]				
8	85	90	—	—
6	110	115	100	110
4	140	150	130	140
2	180	195	165	175
1	205	220	185	200
1/0	230	250	215	230
2/0	265	285	245	260
3/0	300	320	275	295
4/0	340	365	315	340
250	370	395	345	370
350	445	480	415	450
500	540	580	510	545
750	665	720	635	680
1000	780	840	740	795
Two Circuits, Six Conductors [See Figure 311.60(~~C~~)(~~3~~F), Detail 10.]				
8	80	85	—	—
6	100	110	95	100
4	130	140	125	130
2	165	180	155	165
1	190	200	175	190
1/0	215	230	200	215
2/0	245	260	225	245
3/0	275	295	255	275
4/0	310	335	290	315
250	340	365	320	345
350	410	440	385	415
500	495	530	470	505
750	610	655	580	625
1000	710	765	680	730

Informational Note: Refer to 311.60(F) for basis of ampacities and table 311.10(A) for the temperature rating of the conductor.

Table 311.60(C)(83) Ampacities of Three Insulated Copper Conductors Cabled Within an Overall Covering (Three-Conductor Cable), Directly Buried in Earth ~~Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure 311.60(C)(3), 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures of 90°C (194°F) and 105°C (221°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit [See Figure 311.60(~~C~~)(~~3~~E), Detail 5.]				
8	85	89	—	—
6	105	115	115	120
4	135	150	145	155
2	180	190	185	200
1	200	215	210	225
1/0	230	245	240	255
2/0	260	280	270	290
3/0	295	320	305	330
4/0	335	360	350	375
250	365	395	380	410
350	440	475	460	495
500	530	570	550	590
750	650	700	665	720
1000	730	785	750	810
Two Circuits [See Figure 311.60(~~C~~)(~~3~~E), Detail 6.]				
8	80	84	—	—
6	100	105	105	115
4	130	140	135	145
2	165	180	170	185
1	185	200	195	210
1/0	215	230	220	235
2/0	240	260	250	270
3/0	275	295	280	305
4/0	310	335	320	345
250	340	365	350	375
350	410	440	420	450
500	490	525	500	535
750	595	640	605	650
1000	665	715	675	730

Informational Note: Refer to 311.60(F) for basis of ampacities and table 311.10(A) for the temperature rating of the conductor.

Table 311.60(C)(84) Ampacities of Three Insulated Aluminum Conductors Cabled Within an Overall Covering (Three-Conductor Cable), Directly Buried in Earth ~~Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure 311.60(C)(3), 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures of 90°C (194°F) and 105°C (221°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit [See Figure 311.60(~~C~~)(~~3~~E), Detail 5.]				
8	65	70	—	—
6	80	88	90	95
4	105	115	115	125
2	140	150	145	155
1	155	170	165	175
1/0	180	190	185	200
2/0	205	220	210	225
3/0	230	250	240	260
4/0	260	280	270	295
250	285	310	300	320
350	345	375	360	390
500	420	450	435	470
750	520	560	540	580
1000	600	650	620	665
Two Circuits [See Figure 311.60(~~C~~)(~~3~~E), Detail 6.]				
8	60	66	—	—
6	75	83	80	95
4	100	110	105	115
2	130	140	135	145
1	145	155	150	165
1/0	165	180	170	185
2/0	190	205	195	210
3/0	215	230	220	240
4/0	245	260	250	270
250	265	285	275	295
350	320	345	330	355
500	385	415	395	425
750	480	515	485	525
1000	550	590	560	600

Informational Note: Refer to 311.60(F) for basis of ampacities and table 311.10(A) for the temperature rating of the conductor.

Table 311.60(C)(85) Ampacities of Three Triplexed Single Insulated Copper Conductors Directly Buried in Earth ~~Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure 311.60(C)(3), 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures 90°C (194°F) and 105°C (221°F)~~

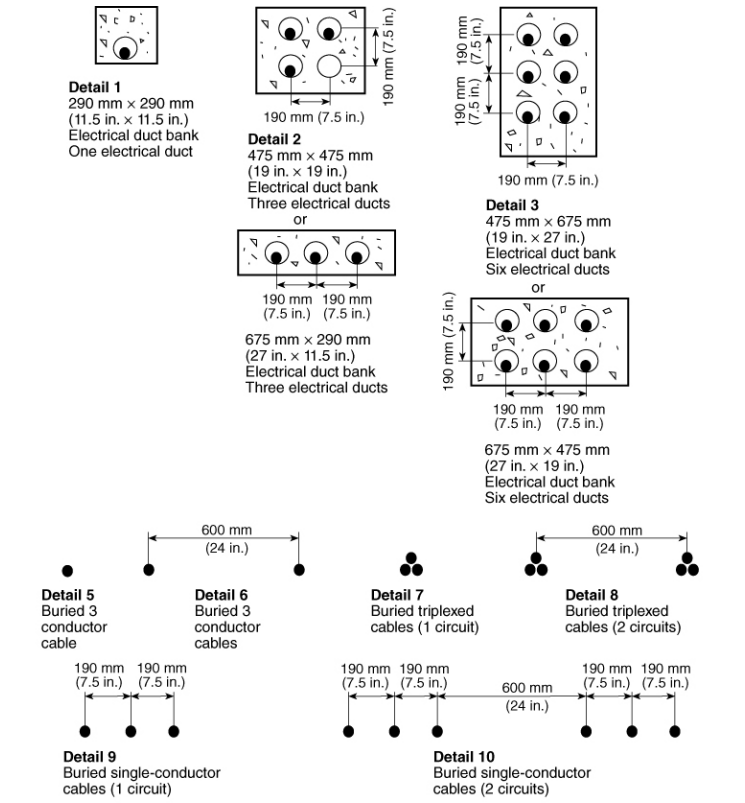
Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10 (A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit, Three Conductors [See Figure 311.60(~~C~~)(~~3~~F), Detail 7.]				
8	90	95	—	—
6	120	130	115	120
4	150	165	150	160
2	195	205	190	205
1	225	240	215	230
1/0	255	270	245	260
2/0	290	310	275	295
3/0	330	360	315	340
4/0	375	405	360	385
250	410	445	390	410
350	490	580	470	505
500	590	635	565	605
750	725	780	685	740
1000	825	885	770	830
Two Circuits, Six Conductors [See Figure 311.60(~~C~~)(~~3~~F), Detail 8.]				
8	85	90	—	—
6	110	115	105	115
4	140	150	140	150
2	180	195	175	190
1	205	220	200	215
1/0	235	250	225	240
2/0	265	285	255	275
3/0	300	320	290	315
4/0	340	365	325	350
250	370	395	355	380
350	445	480	425	455
500	535	575	510	545
750	650	700	615	660
1000	740	795	690	745

Informational Note: Refer to 311.60(F) for basis of ampacities and table 311.10(A) for the temperature rating of the conductor.

Table 311.60(C)(86) Ampacities of Three Triplexed Single Insulated Aluminum Conductors Directly Buried in Earth ~~Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure 311.60(C)(3), 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperatures 90°C (194°F) and 105°C (221°F)~~

Conductor Size (AWG or kcmil)	Temperature Rating of Conductor ~~[See Table 311.10(A).]~~			
	2001–5000 Volts Ampacity		5001–35,000 Volts Ampacity	
	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105	90°C (194°F) Type MV-90	105°C (221°F) Type MV-105
One Circuit, Three Conductors [See Figure 311.60(~~C~~)(~~3~~F), Detail 7.]				
8	70	75	—	—
6	90	100	90	95
4	120	130	115	125
2	155	165	145	155
1	175	190	165	175
1/0	200	210	190	205
2/0	225	240	215	230
3/0	255	275	245	265
4/0	290	310	280	305
250	320	350	305	325
350	385	420	370	400
500	465	500	445	480
750	580	625	550	590
1000	670	725	635	680
Two Circuits, Six Conductors [See Figure 311.60(~~C~~)(~~3~~F), Detail 8.]				
8	65	70	—	—
6	85	95	85	90
4	110	120	105	115
2	140	150	135	145
1	160	170	155	170
1/0	180	195	175	190
2/0	205	220	200	215
3/0	235	250	225	245
4/0	265	285	255	275
250	290	310	280	300
350	350	375	335	360
500	420	455	405	435
750	520	560	485	525
1000	600	645	565	605

Informational Note: Refer to 311.60(F) for basis of ampacities and table 311.10(A) for the temperature rating of the conductor.



Note: Minimum burial depths to top electrical ducts or cables shall be in accordance with 300.50. Maximum depth to the top of electrical duct banks shall be 750 mm (30 in.) and maximum depth to the top of direct-buried cables shall be 900 mm (36 in.).

FIGURE 311.60(~~FC~~)(~~6~~) Cable Installation Dimensions for Use with Table 311.60(C)(77) Through Table 311.60(C)(86).

Article 310

Conductors for General Wiring

Part I. General

310.1 Scope.

This article covers general requirements for conductors rated up to and including 2000 volts 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.

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

310.3 Conductors [moved from 310.106]

(A) Minimum Size of Conductors.

The minimum size of conductors for voltage ratings up to and including 2000 volts shall be 14 AWG copper or 12 AWG aluminum or copper-clad aluminum, except as permitted elsewhere in this Code.

(B) Conductor Material.

Conductors in this article shall be of aluminum, copper-clad aluminum, or copper unless otherwise specified.

Solid aluminum conductors 8, 10, and 12 AWG shall be made of an AA-8000 series electrical grade aluminum alloy conductor material. Stranded aluminum conductors 8 AWG through 1000 kcmil marked as Type RHH, RHW, XHHW, XHHN, XHWN, THW, THHW, THWN, THHN, service-entrance Type SE Style U, and SE Style R shall be made of an AA-8000 series electrical grade aluminum alloy conductor material.

For a copper-clad aluminum conductor, the copper shall form a minimum of 10 percent of the cross-sectional area of a solid conductor or each strand of a stranded conductor. The aluminum core of a copper-clad aluminum conductor shall be made of an AA-8000 series electric grade aluminum alloy conductor material.

(C) Stranded Conductors.

Where installed in raceways, conductors 8 AWG and larger shall be stranded, ~~not~~ unless specifically permitted or required elsewhere in this Code to be solid~~, shall be stranded~~.

(D) Insulated.

Conductors, not specifically permitted elsewhere in this Code to be covered or bare, shall be insulated.

Informational Note: See 250.184 for insulation of neutral conductors of a solidly grounded high-voltage system.

Part II. Construction Specifications [moved from Part III, 310.104]

310.4 Conductor Constructions and Applications. [moved from 310.104]

Insulated conductors shall comply with the applicable provisions of Table 310.4(A) and Table 310.4(B).

Informational Note: Thermoplastic insulation may stiffen at temperatures lower than -10C (+14F). Thermoplastic insulation may also be deformed at normal temperatures where subjected to pressure, such as at points of support.

Table 310.4(A) Conductor Applications and Insulations Rated 600 Volts[1]

Trade Designation	Type Letter	Maximum Operating Temperature	Application Provisions	Insulation	Thickness of Insulation					Outer Covering2
					AWG or kcmil	mm		mils		
Fluorinated ethylene propylene	FEP or FEPB	90°C (194°F)	Dry and damp locations	Fluorinated ethylene propylene	14–10	0.51		20		None
					8–2	0.76		30		
		200°C (392°F)	Dry locations — special applications3		14–8	0.36		14		Glass braid
				Fluorinated ethylene propylene	6–2	0.36		14		Glass or other suitable braid material
Mineral insulation (metal sheathed)	MI	90°C (194°F)	Dry and wet locations	Magnesium oxide	18–164	0.58		23		Copper or alloy steel
					16–10	0.91		36		
		250°C (482°F)	For special applications3		9–4	1.27		50		
					3–500	1.40		55		
Moisture-, heat-, and oil-resistant thermoplastic	MTW	60°C (140°F)	Machine tool wiring in wet locations	Flame-retardant, moisture-, heat-, and oil-resistant		(A)	(B)	(A)	(B)	(A) None (B) Nylon jacket or equivalent
		90°C	Machine tool wiring		22–12	0.76	0.38	30	15	

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Trade Designation	Type Letter	Maximum Operating Temperature	Application Provisions	Insulation	Thickness of Insulation					Outer Covering2
					AWG or kcmil	mm		mils		
		(194°F)	in dry locations.	thermoplastic	10	0.76	0.51	30	20	
					8	1.14	0.76	45	30	
					6	1.52	0.76	60	30	
					4–2	1.52	1.02	60	40	
			Informational Note: See NFPA 79.		1–4/0	2.03	1.27	80	50	
					213–500	2.41	1.52	95	60	
					501–1000	2.79	1.78	110	70	
Paper		85°C (185°F)	For underground service conductors, or by special permission	Paper						Lead sheath
Perfluoro-alkoxy	PFA	90°C (194°F)	Dry and damp locations	Perfluoro-alkoxy	14–10	0.51		20		None
					8–2	0.76		30		
		200°C (392°F)	Dry locations — special applications3		1–4/0	1.14		45		
Perfluoro-alkoxy	PFAH	250°C (482°F)	Dry locations only. Only for leads within apparatus or within raceways	Perfluoro-alkoxy	14–10	0.51		20		None
					8–2	0.76		30		
					1–4/0	1.14		45		

Trade Designation	Type Letter	Maximum Operating Temperature	Application Provisions	Insulation	Thickness of Insulation			Outer Covering2
					AWG or kcmil	mm	mils	
			connected to apparatus (nickel or nickel-coated copper only)					
Thermoset	RHH	90°C (194°F)	Dry and damp locations		14-10	1.14	45	Moisture-resistant, flame-retardant, nonmetallic covering 2
					8–2	1.52	60	
					1–4/0	2.03	80	
					213–500	2.41	95	
					501–1000	2.79	110	
					1001–2000	3.18	125	
Moisture-resistant thermoset	RHW	75°C (167°F)	Dry and wet locations	Flame-retardant, moisture-resistant thermoset	14–10	1.14	45	Moisture-resistant, flame-retardant, nonmetallic covering
					8–2	1.52	60	
					1–4/0	2.03	80	
	RHW-2	90°C (194°F)			213–500	2.41	95	
					501–1000	2.79	110	
					1001–2000	3.18	125	
Silicone	SA	90°C (194°F)	Dry and damp locations	Silicone rubber	14–10	1.14	45	Glass or other suitable
					8–2	1.52	60	

Trade Designation	Type Letter	Maximum Operating Temperature	Application Provisions	Insulation	Thickness of Insulation			Outer Covering2
					AWG or kcmil	mm	mils	
		200°C (392°F)	For special application 3		1–4/0	2.03	80	braid material
					213–500	2.41	95	
					501–1000	2.79	110	
					1001–2000	3.18	125	
Thermoset	SIS	90°C (194°F)	Switchboard and switchgear wiring only	Flame-retardant thermoset	14–10	0.76	30	None
					8–2	1.14	45	
					1–4/0	2.41	55	
Thermoplastic and fibrous outer braid	TBS	90°C (194°F)	Switchboard and switchgear wiring only	Thermoplastic	14–10	0.76	30	Flame-retardant, nonmetallic covering
					8	1.14	45	
					6–2	1.52	60	
					1–4/0	2.03	80	
Extended polytetra-fluoro-ethylene	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	Extruded polytetra-fluoroethylene	14–10	0.51	20	None
					8–2	0.76	30	
					1–4/0	1.14	45	

Trade Designation	Type Letter	Maximum Operating Temperature	Application Provisions	Insulation	Thickness of Insulation			Outer Covering2
					AWG or kcmil	mm	mils	
			copper only)					
Heat-resistant thermoplastic	THHN	90°C (194°F)	Dry and damp locations	Flame-retardant, heat-resistant thermoplastic	14–12	0.38	15	Nylon jacket or equivalent
					10	0.51	20	
					8–6	0.76	30	
					4–2	1.02	40	
					1–4/0	1.27	50	
					250–500	1.52	60	
					501–1000	1.78	70	
Moisture- and heat-resistant thermoplastic	THHW	75°C (167°F) 90°C (194°F)	Wet location Dry location	Flame-retardant, moisture- and heat-resistant thermoplastic	14–10	0.76	30	None
					8	1.14	45	
					6–2	1.52	60	
					1–4/0	2.03	80	
					213–500	2.41	95	
					501–1000	2.79	110	
					1001–2000	3.18	125	
Moisture- and heat-resistant thermoplastic	THW	75°C (167°F) 90°C (194°F)	Dry and wet locations Special applications within	Flame-retardant, moisture- and heat-resistant thermoplastic	14–10	0.76	30	None
					8	1.14	45	
					6–2	1.52	60	
					1–4/0	2.03	80	

Trade Designation	Type Letter	Maximum Operating Temperature	Application Provisions	Insulation	Thickness of Insulation			Outer Covering2
					AWG or kcmil	mm	mils	
			electric discharge lighting equipment. Limited to 1000 open-circuit volts or less. (Size 14-8 only as permitted in 410.68.)		213–500	2.41	95	
					501–1000	2.79	110	
					1001–2000	3.18	125	
	THW-2	90°C (194°F)	Dry and wet locations					
Moisture- and heat-resistant thermoplastic	THWN	75°C (167°F)	Dry and wet locations	Flame-retardant, moisture- and heat-resistant thermoplastic	14–12	0.38	15	Nylon jacket or equivalent
					10	0.51	20	
					8–6	0.76	30	
					4–2	1.02	40	
	THWN-2	90°C (194°F)			1–4/0	1.27	50	
					250–500	1.52	60	
					501–1000	1.78	70	
Moisture-resistant thermoplastic	TW	60°C (140°F)	Dry and wet locations	Flame-retardant, moisture-resistant thermoplastic	14–10	0.76	30	None
					8	1.14	45	
					6–2	1.52	60	
					1–4/0	2.03	80	
					213–500	2.41	95	

Trade Designation	Type Letter	Maximum Operating Temperature	Application Provisions	Insulation	Thickness of Insulation			Outer Covering2
					AWG or kcmil	mm	mils	
					501–1000	2.79	110	
					1001–2000	3.18	125	
Underground feeder and branch-circuit cable — single conductor (for Type UF cable employing more than one conductor, see Article 340).	UF	60°C (140°F)	See Article 340.	Moisture-resistant	14–10	1.52	606	Integral with insulation
					8–2	2.03	806	
		75°C (167°F)5		Moisture- and heat-resistant	1–4/0	2.41	956	
Underground service-entrance cable — single conductor (for Type USE cable employing more than one conductor, see Article 338).	USE	75°C (167°F)5	See Article 338.	Heat- and moisture-resistant	14–10	1.14	45	Moisture-resistant nonmetallic covering (See 338.2.)
					8–2	1.52	60	
					1–4/0	2.03	80	
					213–500	2.41	95 7	
					501–1000	2.79	110	
					1001–2000	3.18	125	
	USE-2	90°C (194°F)	Dry and wet locations					
Thermoset	XHH	90°C (194°F)	Dry and damp locations	Flame-retardant thermoset	14–10	0.76	30	None
					8–2	1.14	45	
					1–4/0	1.40	55	

Trade Designation	Type Letter	Maximum Operating Temperature	Application Provisions	Insulation	Thickness of Insulation			Outer Covering2
					AWG or kcmil	mm	mils	
					213–500	1.65	65	
					501–1000	2.03	80	
					1001–2000	2.41	95	
Thermoset	XHHN	90°C (194°F)	Dry and damp locations	Flame-retardant thermoset	14–12	0.38	15	Nylon jacket or equivalent
					10	0.51	20	
					8–6	0.76	30	
					4–2	1.02	40	
					1–4/0	1.27	50	
					250–500	1.52	60	
					501–1000	1.78	70	
Moisture-resistant thermoset	XHHW	90°C (194°F)	Dry and damp locations	Flame-retardant, moisture-resistant thermoset	14–10	0.76	30	None
					8–2	1.14	45	
		75°C (167°F)	Wet locations		1–4/0	1.40	55	
					213–500	1.65	65	
					501–1000	2.03	80	
					1001–2000	2.41	95	
Moisture-resistant thermoset	XHHW-2	90°C (194°F)	Dry and wet locations	Flame-retardant, moisture-	14–10	0.76	30	None
					8–2	1.14	45	

Trade Designation	Type Letter	Maximum Operating Temperature	Application Provisions	Insulation	Thickness of Insulation			Outer Covering2
					AWG or kcmil	mm	mils	
				resistant thermoset	1–4/0	1.40	55	
					213–500	1.65	65	
					501–1000	2.03	80	
					1001–2000	2.41	95	
Moisture-resistant thermoset	XHWN	75°C (167°F)	Dry and wet locations	Flame-retardant, moisture-resistant thermoset	14–12	0.38	15	Nylon jacket or equivalent
					10	0.51	20	
					8–6	0.76	30	
	XHWN-2	90°C (194°F)			4–2	1.02	40	
					1–4/0	1.27	50	
					250–500	1.52	60	
					501–1000	1.78	70	
Modified ethylene tetrafluoro-ethylene	Z	90°C (194°F)	Dry and damp locations	Modified ethylene tetrafluoro-ethylene	14–12	0.38	15	None
					10	0.51	20	
		150°C (302°F)	Dry locations — special applications3		8–4	0.64	25	
					3–1	0.89	35	
					1/0–4/0	1.14	45	
Modified ethylene tetrafluoro-ethylene	ZW	75°C (167°F)	Wet locations	Modified ethylene tetrafluoro-ethylene	14–10	0.76	30	None
		90°C (194°F)	Dry and damp locations		8–2	1.14	45	

Trade Designation	Type Letter	Maximum Operating Temperature	Application Provisions	Insulation	Thickness of Insulation			Outer Covering2
					AWG or kcmil	mm	mils	
		150°C (302°F)	Dry locations — special applications3					
	ZW-2	90°C (194°F)	Dry and wet locations					

[1]Conductors shall be permitted to be rated up to 1000 V if listed and marked.

[2] Outer coverings shall not be required where listed without a covering.

[3] Where design conditions require maximum conductor operating temperatures above 90°C (194°F).

[4] For signaling circuits permitting 300-volt insulation.

[5] For ampacity limitation, see 340.80.

[6] Includes integral jacket.

[7] Insulation thickness shall be permitted to be 2.03 mm (80 mils) for listed Type USE conductors that have been subjected to special investigations. 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 330.104. For nonmetallic-sheathed cable, see Article 334, Part III. For Type UF cable, see Article 340, Part III.

Commented [CK2]: Table notes should be mandatory

Table 310.4(B) Thickness of Insulation for Nonshielded Types RHH and RHW Solid Dielectric Insulated Conductors Rated 2000 Volts

Conductor Size (AWG or kcmil)	Column A[1]		Column B[2]	
	mm	mils	mm	mils
14–10	2.03	80	1.52	60
8	2.03	80	1.78	70
6–2	2.41	95	1.78	70
1–2/0	2.79	110	2.29	90
3/0–4/0	2.79	110	2.29	90
213–500	3.18	125	2.67	105

Conductor Size (AWG or kcmil)	Column A[1]		Column B[2]	
	mm	mils	mm	mils
501–1000	3.56	140	3.05	120
1001–2000	3.56	140	3.56	140

[1]Column A insulations are limited to natural, SBR, and butyl rubbers.

[2]Column B insulations are materials such as cross-linked polyethylene, ethylene propylene rubber, and composites thereof.

Commented [CK3]: Table notes should be mandatory

310.6 Conductor Identification. [moved from 310.110]

(A) Grounded Conductors.
Insulated or covered grounded conductors shall be identified in accordance with 200.6.

(B) Equipment Grounding Conductors.
Equipment grounding conductors shall be identified in accordance with 250.119.

(C) Ungrounded Conductors.
Conductors that are intended for use as ungrounded conductors, whether used as a single conductor or in multiconductor cables, shall be finished to be clearly distinguishable from grounded, ~~and~~ grounding, and bonding conductors. Distinguishing markings shall not conflict in any manner with the surface markings required by 310.8(B)(1). Branch-circuit ungrounded conductors shall be identified in accordance with 210.5(C). Feeders shall be identified in accordance with 215.12.
Exception: Conductor identification shall be permitted in accordance with 200.7.

310.8 Marking. [moved from 310.120]

(A) Required Information.
All conductors and cables shall be marked to indicate the following information, using the applicable method described in 310.8(B):
(1) The maximum rated voltage.
(2) The proper type letter or letters for the type of wire or cable as specified elsewhere in this Code.
(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.
Informational Note: See Conductor Properties, Table 8 of Chapter 9, for conductor area expressed in SI units for conductor sizes specified in AWG or circular mil area.
(5) Cable assemblies where the neutral conductor is smaller than the ungrounded conductors shall be so marked.

(B) Method of Marking.
(1) Surface Marking.
The following conductors and cables shall be durably marked on the surface. The AWG size or circular mil area shall be repeated at intervals not exceeding 610 mm (24 in.). All other markings shall be repeated at intervals not exceeding 1.0 m (40 in.).
(1) Single-conductor and multiconductor rubber- and thermoplastic-insulated wire and cable

(2) Nonmetallic-sheathed cable
(3) Service-entrance cable
(4) Underground feeder and branch-circuit cable
(5) Tray cable
(6) Irrigation cable
(7) Power-limited tray cable
(8) Instrumentation 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: Type MI cable.
Exception No. 2: Type AC cable.
Exception No. 3: The information required in 310.8(A) shall be permitted to be durably marked on the outer nonmetallic covering of Type MC, Type ITC, or Type PLTC cables at intervals not exceeding 1.0 m (40 in.).
Exception No. 4: The information required in 310.8(A) shall be permitted to be durably marked on a nonmetallic covering under the metallic sheath of Type ITC or Type PLTC cable at intervals not exceeding 1.0 m (40 in.).
Informational Note: Included in the group of metal-covered cables are Type AC cable (Article 320), Type MC cable (Article 330), 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:
(1) Type MI cable
(2) Switchboard wires
(3) Metal-covered, single-conductor cables
(4) Type AC cable

(4) Optional Marking of Wire Size.
The information required in 310.8(A)(4) shall be permitted to be marked on the surface of the individual insulated conductors for the following multiconductor cables:
(1) Type MC cable
(2) Tray cable
(3) Irrigation cable
(4) Power-limited tray cable
(5) Power-limited fire alarm cable
(6) Instrumentation tray cable

(C) Suffixes to Designate Number of Conductors.
A type letter or letters used alone shall indicate a single insulated conductor. The letter suffixes shall be indicated as follows:
(1) D — For two insulated conductors laid parallel within an outer nonmetallic covering
(2) M — For an assembly of two or more insulated conductors twisted spirally within an outer nonmetallic covering

(D) Optional Markings.
All conductors and cables contained in Chapter 3 shall be permitted to be surface marked to indicate special characteristics of the cable materials. These markings include, but are not limited to, markings for limited smoke, sunlight resistant, and so forth.

Part III. Installation. **[is Part II in current edition]**

310.10 Uses Permitted.

The conductors described in 310.4 shall be permitted for use in any of the wiring methods covered in Chapter 3 and as specified in their respective tables or as permitted elsewhere in this Code.

(A) Dry Locations.
Insulated conductors and cables used in dry locations shall be any of the types identified in this Code.

(B) Dry and Damp Locations.
Insulated conductors and cables used in dry and damp locations shall be Types FEP, FEPB, MTW, PFA, RHH, RHW, RHW-2, SA, THHN, THW, THW-2, THHW, THWN, THWN-2, TW, XHH, XHHW, XHHW-2, XHHN, XHWN, XHWN-2, Z, or ZW.

(C) Wet Locations.
Insulated conductors and cables used in wet locations shall comply with one of the following:
(1) Be moisture-impervious metal-sheathed
(2) Be types MTW, RHW, RHW-2, TW, THW, THW-2, THHW, THWN, THWN-2, XHHW, XHHW-2, XHWN, XHWN-2 or ZW
(3) Be of a type listed for use in wet locations

(D) Locations Exposed to Direct Sunlight.
Insulated conductors or cables used where exposed to direct rays of the sun shall comply with (D)(1) or (D)(2):
(1) Conductors and cables shall be listed, or listed and marked, as being sunlight resistant
(2) Conductors and cables shall be covered with insulating material, such as tape or sleeving, that is listed, or listed and marked, as being sunlight resistant

(E) Direct-Burial Conductors.
Conductors used for direct-burial applications shall be of a type identified for such use.

(F) Corrosive Conditions.

Conductors exposed to oils, greases, vapors, gases, fumes, liquids, or other substances having a deleterious effect on the conductor or insulation shall be of a type suitable for the application.

(G) Conductors in Parallel.

(1) General.

Aluminum, copper-clad aluminum, or copper conductors, for each phase, polarity, neutral, or grounded circuit shall be permitted to be connected in parallel (electrically joined at both ends) only in sizes 1/0 AWG and larger where installed in accordance with 310.10(G)(2) through (G)(6).

Exception No. 1: Conductors in sizes smaller than 1/0 AWG shall be permitted to be run in parallel to supply control power to indicating instruments, contactors, relays, solenoids, and similar control devices, or for frequencies of 360 Hz and higher, provided all of the following apply:

(a) They are contained within the same raceway or cable.

(b) The ampacity of each individual conductor is sufficient to carry the entire load current shared by the parallel conductors.

(c) The overcurrent protection is such that the ampacity of each individual conductor will not be exceeded if one or more of the parallel conductors become inadvertently disconnected.

Exception No. 2: Under engineering supervision, 2 AWG and 1 AWG grounded neutral conductors shall be permitted to be installed in parallel for existing installations.

Informational Note to Exception No. 2: Exception No. 2 can be used to alleviate overheating of neutral conductors in existing installations due to high content of triplen harmonic currents.

(2) Conductor and Installation Characteristics.

The paralleled conductors in each phase, polarity, neutral, grounded circuit conductor, equipment grounding conductor, or equipment bonding jumper shall comply with all of the following:

(1) Be the same length.
(2) Consist of the same conductor material.
(3) Be the same size in circular mil area.
(4) Have the same insulation type.
(5) Be terminated in the same manner.

(3) Separate Cables or Raceways.

Where run in separate cables or raceways, the cables or raceways with conductors shall have the same number of conductors and shall have the same electrical characteristics. Conductors of one phase, polarity, neutral, grounded circuit conductor, or equipment grounding conductor shall not be required to have the same physical characteristics as those of another phase, polarity, neutral, grounded circuit conductor, or equipment grounding conductor.

(4) Ampacity Adjustment.

Conductors installed in parallel shall comply with the provisions of 310.15(eC)(1)~~(B)(3)(a)~~.

(5) Equipment Grounding Conductors.

Where parallel equipment grounding conductors are used, they shall be sized in accordance with 250.122. Sectioned equipment grounding conductors smaller than 1/0 AWG shall be permitted in multiconductor cables, if the combined circular mil area of the sectioned equipment grounding conductors in each cable complies with 250.122.

(6) Bonding Jumpers.

Where parallel equipment bonding jumpers or supply-side bonding jumpers are installed in raceways, they shall be sized and installed in accordance with 250.102.

310.12 Single-Phase Dwelling Services and Feeders. [moved from 310.15(B)(7)]

For one-family dwellings and the individual dwelling units of two-family and multifamily dwellings, service and feeder conductors supplied by a single-phase, 120/240-volt system shall be permitted to be sized in accordance with 310.12(1) through (4).

For one-family dwellings and the individual dwelling units of two-family and multifamily dwellings, single-phase feeder conductors consisting of 2 ungrounded conductors and the neutral conductor from a 208Y/120 volt system shall be permitted to be sized in accordance with 310.12(1) through (3).

(1) For a service rated 100 through 400 amperes, the service conductors supplying the entire load associated with a one-family dwelling, or the service conductors supplying the entire load associated with an individual dwelling unit in a two-family or multifamily dwelling, shall be permitted to have an ampacity not less than 83 percent of the service rating. If no adjustment or correction factors are required, Table 310.12 shall be permitted to be applied.

(2) For a feeder rated 100 through 400 amperes, the feeder conductors supplying the entire load associated with a one-family dwelling, or the feeder conductors supplying the entire load associated with an individual dwelling unit in a two-family or multifamily dwelling, shall be permitted to have an ampacity not less than 83 percent of the feeder rating. If no adjustment or correction factors are required, Table 310.12 shall be permitted to be applied.

(3) In no case shall a feeder for an individual dwelling unit be required to have an ampacity greater than that specified in 310.12(1) or (2).

(4) Grounded conductors shall be permitted to be sized smaller than the ungrounded conductors, if the requirements of 220.61 and 230.42 for service conductors or the requirements of 215.2 and 220.61 for feeder conductors are met.

Where correction or adjustment factors are required by 310.15(B) or (C), they shall be permitted to be applied to the ampacity associated with the temperature rating of the conductor.

Informational Note No. 1: The service or feeder ratings addressed by this section are based on the standard ~~ampere ampacity~~ ratings for fuses and inverse time circuit breakers from 240.6(A).

Informational Note No. 2: See Example D7 in Annex D.

Table 310.12 Single-Phase Dwelling Services and Feeders.

	Conductor (AWG or kcmil)	
Service or Feeder Rating (Amperes)	Copper	Aluminum or Copper-Clad Aluminum
100	4	2
110	3	1
125	2	1/0
150	1	2/0
175	1/0	3/0
200	2/0	4/0
225	3/0	250
250	4/0	300
300	250	350
350	350	500
400	400	600

Note: If no adjustment or correction factors are required, this table shall be permitted to be applied.

310.14 Ampacities for Conductors Rated 0-2000 Volts. [moved from 310.15]

(A) General.

(1) Tables or Engineering Supervision.
Ampacities for conductors shall be permitted to be determined by tables as provided in 310.15 or under engineering supervision, as provided in 310.14(B).
Informational Note No. 1: Ampacities provided by this section do not take voltage drop into consideration. See 210.19(A), Informational Note No. 4, for branch circuits and 215.2(A), Informational Note No. 2, for feeders.
Informational Note No. 2: For the allowable ampacities of Type MTW wire, see Table 12~~13~~.5.1 in NFPA 79-2015, Electrical Standard for Industrial Machinery.

(2) Selection of Ampacity.
Where more than one ampacity applies for a given circuit length, the lowest value shall be used.
Exception: Where different ampacities apply to portions of a circuit, the higher ampacity shall be permitted to be used if the total portion(s) of the circuit with lower ampacity does not exceed the lesser of 3.0 m (10 ft) or 10 percent of the total circuit.
Informational Note: See 110.14(C) for conductor temperature limitations due to termination provisions.

(3) Temperature Limitation of Conductors.
No conductor shall be used in such a manner that its operating temperature exceeds 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.
Informational Note No. 1: The temperature rating of a conductor [see Table 310.4(A)] is the maximum temperature, at any location along its length, that the conductor can withstand over a prolonged time period without serious degradation. The ~~allowable~~ ampacity tables~~, the ampacity tables~~ of Article 310 and the ampacity tables of Informative Annex B, the ambient temperature correction factors in 310.15(B), and the notes to the tables provide guidance for coordinating conductor sizes, types, ~~allowable ampacities,~~ ampacities, ambient temperatures, and number of associated conductors. The principal determinants of operating temperature are as follows:
(1) Ambient temperature — ambient temperature may vary along the conductor length as well as from time to time.
(2) Heat generated internally in the conductor as the result of load current flow, including fundamental and harmonic currents.
(3) The rate at which generated heat dissipates into the ambient medium. Thermal insulation that covers or surrounds conductors affects the rate of heat dissipation.
(4) Adjacent load-carrying conductors — adjacent conductors have the dual effect of raising the ambient temperature and impeding heat dissipation.
Informational Note No. 2: Refer to 110.14(C) for the temperature limitation of terminations.

(B) Engineering Supervision. [NEW]

Under engineering supervision, conductor ampacities shall be permitted to be calculated by means of the following general equation:

$$I = \sqrt{\frac{T_c - T_a}{R_{dc}(1+Y_c)R_{ca}}} \times 10^3 \text{ amperes}$$ **[310.14(B)]**

where:

T_c = conductor temperature in degrees Celsius (°C)

T_a = ambient temperature in degrees Celsius (°C)

R_{dc} = dc resistance of 305 mm (1 ft) of conductor in microohms

at temperature, *Tc*

Y_c = component ac resistance resulting from skin effect and

proximity effect

R_{ca} = effective thermal resistance between conductor and surrounding ambient

310.15 Ampacity Tables. [moved from 310.15(B)]

Ampacities for conductors rated 0 volts to 2000 volts shall be as specified in the ~~Allowable~~ Ampacity Tables 310.16 through Table 310.2119, ~~and Ampacity Table 310.20 and Table 310.21~~ as modified by 310.15(A) through (F) and 310.12. Under engineering supervision, ampacities of sizes not shown in ampacity tables for conductors meeting the general wiring requirements shall be permitted to be determined by interpolation of the adjacent conductors based on the conductor's area.

The temperature correction and adjustment factors shall be permitted to be applied to the ampacity for the temperature rating of the conductor, if the corrected and adjusted ampacity does not exceed the ampacity for the temperature rating of the termination in accordance with the provisions of 110.14(C).

Informational Note No. 1: Table 310.16 through Table 310.19 are application tables for use in determining conductor sizes on loads calculated in accordance with Article 220. ~~Allowable~~ Aampacities result from consideration of one or more of the following:

(1) Temperature compatibility with connected equipment, especially the connection points.

(2) Coordination with circuit and system overcurrent protection.

(3) Compliance with the requirements of product listings or certifications. See 110.3(B).

(4) Preservation of the safety benefits of established industry practices and standardized procedures.

Informational Note No. 2: For conductor area see Chapter 9, Table 8, Conductor Properties.

Informational Note No. 3: For the ampacities of flexible cords and cables, see 400.5. For the ampacities of fixture wires, see 402.5.

(A) General. **[moved from 310.15(B)(1)]**

For explanation of type letters used in tables and for recognized sizes of conductors for the various conductor insulations, see Table 310.4(A) and Table 310.4(B). For installation requirements, see 310.1 through 310.14 and the various articles of this Code. For flexible cords, see Table 400.4, Table 400.5(A)(1), and Table 400.5(A)(2).

(B) Ambient Temperature Correction Factors. **[moved from 310.15(B)(2)]**

Ampacities for ambient temperatures other than those shown in the ampacity tables shall be corrected in accordance with Table 310.15(B)(1) or Table 310.15(B)(2), or shall be permitted to be calculated using the following equation:

$$I' = I\sqrt{\frac{T_c - T_a'}{T_c - T_a}}$$ ***[310.15(B)]***

where:

I' = ampacity corrected for ambient temperature

I = ampacity shown in the tables

T_c = temperature rating of conductor (°C)

T_a' = new ambient temperature (°C)

T_a = ambient temperature used in the table (°C)

Table 310.15(B)(1) Ambient Temperature Correction Factors Based on 30C (86F)

For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate correction factor shown below.				
Ambient Temperature (°C)	**Temperature Rating of Conductor**			**Ambient Temperature (°F)**
	60°C	**75°C**	**90°C**	
10 or less	**1.29**	**1.20**	**1.15**	**50 or less**

For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate correction factor shown below.				
Ambient Temperature (°C)	Temperature Rating of Conductor			Ambient Temperature (°F)
	60°C	75°C	90°C	
11–15	1.22	1.15	1.12	51–59
16–20	1.15	1.11	1.08	60–68
21–25	1.08	1.05	1.04	69–77
26–30	1.00	1.00	1.00	78–86
31–35	0.91	0.94	0.96	87–95
36–40	0.82	0.88	0.91	96–104
41–45	0.71	0.82	0.87	105–113
46–50	0.58	0.75	0.82	114–122
51–55	0.41	0.67	0.76	123–131
56–60	—	0.58	0.71	132–140
61–65	—	0.47	0.65	141–149
66–70	—	0.33	0.58	150–158
71–75	—	—	0.50	159–167
76–80	—	—	0.41	168–176
81–85	—	—	0.29	177–185

Table 310.15(B)(2) Ambient Temperature Correction Factors Based on 40C (104F)

For ambient temperatures other than 40°C (104°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate correction factor shown below.

Ambient Temperature (°C)	Temperature Rating of Conductor						Ambient Temperature (ºF)
	60°C	75°C	90°C	150°C	200°C	250°C	
10 or less	1.58	1.36	1.26	1.13	1.09	1.07	50 or less
11–15	1.50	1.31	1.22	1.11	1.08	1.06	51–59
16–20	1.41	1.25	1.18	1.09	1.06	1.05	60–68
21–25	1.32	1.2	1.14	1.07	1.05	1.04	69–77
26–30	1.22	1.13	1.10	1.04	1.03	1.02	78–86
31–35	1.12	1.07	1.05	1.02	1.02	1.01	87–95
36–40	1.00	1.00	1.00	1.00	1.00	1.00	96–104
41–45	0.87	0.93	0.95	0.98	0.98	0.99	105–113
46–50	0.71	0.85	0.89	0.95	0.97	0.98	114–122
51–55	0.50	0.76	0.84	0.93	0.95	0.96	123–131
56–60	—	0.65	0.77	0.90	0.94	0.95	132–140
61–65	—	0.53	0.71	0.88	0.92	0.94	141–149
66–70	—	0.38	0.63	0.85	0.90	0.93	150–158
71–75	—	—	0.55	0.83	0.88	0.91	159–167
76–80	—	—	0.45	0.80	0.87	0.90	168–176
81–90	—	—	—	0.74	0.83	0.87	177–194
91–100	—	—	—	0.67	0.79	0.85	195–212
101–110	—	—	—	0.60	0.75	0.82	213–230
111–120	—	—	—	0.52	0.71	0.79	231–248
121–130	—	—	—	0.43	0.66	0.76	249–266
131–140	—	—	—	0.30	0.61	0.72	267–284
141–160	—	—	—	—	0.50	0.65	285–320
161–180	—	—	—	—	0.35	0.58	321–356
181–200	—	—	—	—	—	0.49	357–392

For ambient temperatures other than 40°C (104°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate correction factor shown below.							
Ambient Temperature (°C)	Temperature Rating of Conductor						Ambient Temperature (°F)
	60°C	75°C	90°C	150°C	200°C	250°C	
201–225	—	—	—	—	—	0.35	393–437

(C) Adjustment Factors. [moved from 310.15(B)(3)]

(1) More than Three Current-Carrying Conductors.

~~Where the~~The ampacity of each conductor shall be reduced as shown in Table 310.15(~~c~~C)(1) where the number of current-carrying conductors in a raceway or cable exceeds three, or where single conductors or multiconductor cables not installed in raceways are installed without maintaining spacing for a continuous length longer than 600 mm (24 in.)~~ and are not installed in raceways, the allowable ampacity of each conductor shall be reduced as shown in Table 310.15(C)(1)~~. Each current-carrying conductor of a paralleled set of conductors shall be counted as a current-carrying conductor.

Table 310.15(C)(1) Adjustment Factors for More Than Three Current-Carrying Conductors

Number of Conductors*	Percent of Values in Table 310.16 Through Table 310.19 as Adjusted for Ambient Temperature if Necessary
4–6	80
7–9	70
10–20	50
21–30	45
31–40	40
41 and above	35

*Number of conductors is the total number of conductors in the raceway or cable, including spare conductors. The count shall be adjusted in accordance with 310.15(E) and (F). The count shall not include conductors that are connected to electrical components that cannot be simultaneously energized.

Notes:

(1~~2~~) ~~Raceway Spacing.~~

Spacing between raceways shall be maintained.

(2~~3~~) ~~Raceways and Cables Exposed to Sunlight on Rooftops.~~

W~~here r~~Raceways or cables ~~are~~ exposed to direct sunlight on or above rooftops., ~~raceways or cables shall be installed a minimum distance above the roof to the bottom of the raceway or cable of 23 mm (7/8 in.).~~ Where the distance above the roof to the bottom of the raceway or cable is less than 23 mm (7/8 in.), a temperature adder of 33°C (60°F) shall be added to the outdoor temperature to determine the applicable ambient temperature for application of the correction factors in Table 310.15(B)(1) or Table 310.15(B)(2).

Exception: Type XHHW-2 insulated conductors shall not be subject to this ampacity adjustment.

Informational Note: One source for the ambient temperatures in various locations is the ASHRAE Handbook — Fundamentals.

Where conductors of different systems, as provided in 300.3, are installed in a common raceway or cable, the adjustment factors shown in Table 310.15(C)(1) shall apply only to the number of power and lighting conductors (Articles 210, 215, 220, and 230).
Informational Note No. 1: See Annex B for adjustment factors for more than three current-carrying conductors in a raceway or cable with load diversity.
Informational Note No. 2: See 366.23 for adjustment factors for conductors and ampacity for bare copper and aluminum bars in auxiliary gutters and 376.22(B) for adjustment factors for conductors in metal wireways.
(a) Where conductors are installed in cable trays, the provisions of 392.80 shall apply.
(b) Adjustment factors shall not apply to conductors in raceways having a length not exceeding 600 mm (24 in.).
(c) Adjustment factors shall not apply to underground conductors entering or leaving an outdoor trench if those conductors have physical protection in the form of rigid metal conduit, intermediate metal conduit, rigid polyvinyl chloride conduit (PVC), or reinforced thermosetting resin conduit (RTRC) having a length not exceeding 3.05 m (10 ft), and if the number of conductors does not exceed four.
(d) Adjustment factors shall not apply to Type AC cable or to Type MC cable under the following conditions:
1. The cables do not have an overall outer jacket.
2. Each cable has not more than three current-carrying conductors.
3. The conductors are 12 AWG copper.
4. Not more than 20 current-carrying conductors are installed without maintaining spacing, are stacked, or are supported on "bridle rings."
Exception to (4~~d~~): If cables meeting the requirements in 310.15(C)(1)(d)1 through 3~~4~~ with more than 20 current-carrying conductors are installed longer than 600 mm (24 in.) without maintaining spacing, are stacked, or are supported on bridle rings, a 60 percent adjustment factor shall be applied.

(D) Bare or Covered Conductors. [moved from 310.15(B)(4)]
Where bare or covered conductors are installed with insulated conductors, the temperature rating of the bare or covered conductor shall be equal to the lowest temperature rating of the insulated conductors for the purpose of determining ampacity.

(E) Neutral Conductor. **[moved from 310.15(B)(5)]**
(1a) A neutral conductor that carries only the unbalanced current from other conductors of the same circuit shall not be required to be counted when applying the provisions of 310.15(C) (1).
(2b) In a 3-wire circuit consisting of two phase conductors and the neutral conductor of a 4-wire, 3-phase, wye-connected system, a common conductor carries approximately the same current as the line-to-neutral load currents of the other conductors and shall be counted when applying the provisions of 310.15(C)(1).
(3c) On a 4-wire, 3-phase wye circuit where the major portion of the load consists of nonlinear loads, harmonic currents are present in the neutral conductor; the neutral conductor shall therefore be considered a current-carrying conductor.

(F) Grounding or Bonding Conductor. **[moved from 310.15(B)(6)]**
A grounding or bonding conductor shall not be counted when applying the provisions of 310.15(C)(1).

310.16 Allowable Ampacities of Insulated Conductors in Raceway, Cable, or Earth (Directly Buried). **[NEW]**

The maximum allowable ampacities shall be as specified in Table 310.16 where all of the following conditions apply:

1a) Ceonductors are rated 0 volts to 2000 volts,.

2b) Ceonductors are rated 60°C (140°F), 75°C (167°F), or 90°C (194°F).,

3c) wWiring is installed in a 30°C (86°F) ambient temperature., and

4d) Tthere are not more than three current-carrying conductors.

310.17 Allowable Ampacities of Single-Insulated Conductors in Free Air. **[NEW]**

The maximum allowable ampacities shall be as specified in Table 310.17 where all of the following conditions apply:

1a) cConductors are rated 0 volts to 2000 volts.,

2b) Ceonductors are rated 60°C (140F), 75°C (167°F), or 90C (194°-F)., and

3c) Wwiring is installed in a 30°C (86°F) ambient temperature.

310.18 Allowable Ampacities of Insulated Conductors in Raceway or Cable. **[NEW]**

The maximum allowable ampacities shall be as specified in Table 310.18 where all of the following conditions apply:

1a) Ceonductors are rated 0 volts to 2000 volts.,

2b) Ceonductors are rated 150°C (302°F), 200°C (392°F), or 250°C (482°-F).,

3c) Wwiring is installed in a 40°C (86°F) ambient temperature, and

4d) Tthere are not more than three current-carrying conductors.

310.19 Allowable Ampacities of Single-Insulated Conductors in Free Air. [NEW]

The maximum allowable ampacities shall be as specified in Table 310.19 where all of the following conditions apply:

1a) Cconductors are rated 0 volts to 2000 volts,

2b) Cconductors are rated up to 250°C (482°-F), and

3c) Wwiring is installed in a 40°C (86°F) ambient temperature.

310.20 Ampacities of Conductors Supported on a Messenger. [NEW]

The maximum ampacities shall be as specified in Table 310.20 where all of the following conditions apply:

1a) cConductors are rated 0 volts to 2000 volts,

2b) cConductors are rated 75°C (167°F) or 90°C (194°-F),

3c) wWiring is installed in a 40°C (86°F) ambient temperature, and.

4d) tThere are not more than three single-insulated conductors.

310.21 Ampacities of Bare or Covered Conductors in Free Air. [NEW]

The maximum ampacities shall be as specified in Table 310.21 where all of the following conditions apply:

1a) wWind velocity is 610 mm/sec (2 ft/sec),

2b) cConductors are 80°C (176°-F) total conductor temperature, and.

3c) wWiring is installed in a 40°C (86°F) ambient temperature.

Table 310.15(B)(16) (formerly Table 310.16) Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts, 60°C Through 90°C (140°F Through 194°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)* [?]

Size AWG or kcmil	Temperature Rating of Conductor [See Table 310.~~10~~4(A)~~.~~]						Size AWG or kcmil
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, XHWN, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, XHWN, XHWN-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, XHWN, USE	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, XHWN, XHWN-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18*~~.~~	—	—	14	—	—	—	—
16*~~.~~	—	—	18	—	—	—	—
14*~~.~~	15	20	25	—	—	—	—
12*~~.~~	20	25	30	15	20	25	12**
10*~~.~~	30	35	40	25	30	35	10**
8	40	50	55	35	40	45	8
6	55	65	75	40	50	55	6
4	70	85	95	55	65	75	4
3	85	100	115	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	145	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	195	230	260	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500
600	350	420	475	285	340	385	600
700	385	460	520	315	375	425	700
750	400	475	535	320	385	435	750
800	410	490	555	330	395	445	800
900	435	520	585	355	425	480	900
1000	455	545	615	375	445	500	1000
1250	495	590	665	405	485	545	1250
1500	525	625	705	435	520	585	1500
1750	545	650	735	455	545	615	1750
2000	555	665	750	470	560	630	2000

Notes:

~~Refer to~~ Section 310.16 shall be referenced for conditions of use.

~~*~~Refer to Section 310.15(B)~~(2)~~ shall be referenced for the ampacity correction factors where the ambient temperature is other than 30°C (86°F).
Refer to ~~**~~ Section 310.15~~(B)(3)(a)~~(C)(1) shall be referenced for more than three current-carrying conductors.
~~*~~* Section Refer to 240.4(D) for conductor overcurrent protection limitations.

Commented [CK4]: Table notes should be mandatory.

~~Table 310.15(B)(17) (formerly~~ Table 310.17~~) Allowable~~ Ampacities of Single-Insulated Conductors ~~Rated Up to and Including 2000 Volts~~ in Free Air~~, Based on Ambient Temperature of 30°C (86°F)*~~

Size AWG or kcmil	Temperature Rating of Conductor [See Table 310.~~10~~4(A)~~.~~]						Size AWG or kcmil
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, XHWN, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, XHWN, XHWN-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, XHWN	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, XHWN, XHWN-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18	—	—	18	—	—	—	—
16	—	—	24	—	—	—	—
14*~~*~~	25	30	35	—	—	—	—
12*~~*~~	30	35	40	25	30	35	12**
10*~~*~~	40	50	55	35	40	45	10**
8	60	70	80	45	55	60	8
6	80	95	105	60	75	85	6
4	105	125	140	80	100	115	4
3	120	145	165	95	115	130	3
2	140	170	190	110	135	150	2
1	165	195	220	130	155	175	1
1/0	195	230	260	150	180	205	1/0
2/0	225	265	300	175	210	235	2/0
3/0	260	310	350	200	240	270	3/0
4/0	300	360	405	235	280	315	4/0
250	340	405	455	265	315	355	250
300	375	445	500	290	350	395	300
350	420	505	570	330	395	445	350
400	455	545	615	355	425	480	400
500	515	620	700	405	485	545	500
600	575	690	780	455	545	615	600
700	630	755	850	500	595	670	700
750	655	785	885	515	620	700	750
800	680	815	920	535	645	725	800
900	730	870	980	580	700	790	900
1000	780	935	1055	625	750	845	1000
1250	890	1065	1200	710	855	965	1250

Size AWG or kcmil	Temperature Rating of Conductor [See Table 310.~~10~~4(A)~~.~~]						Size AWG or kcmil
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, XHWN, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, XHWN, XHWN-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, XHWN	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, XHWN, XHWN-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
1500	980	1175	1325	795	950	1070	1500
1750	1070	1280	1445	875	1050	1185	1750
2000	1155	1385	1560	960	1150	1295	2000

Notes:
~~Refer to~~ Section 310.17 shall be referenced for conditions of use.
~~*Refer to~~ Section 310.15(B)~~(2)~~ shall be referenced for the ampacity correction factors where the ambient temperature is other than 30°C (86°F).
~~*~~*~~Refer to~~ Section 240.4(D) shall be referenced for conductor overcurrent protection limitations.

~~Table 310.15(B)(18) (formerly~~ Table 310.18 ~~) Allowable~~ Ampacities of Insulated Conductors ~~Rated Up to and Including 2000 Volts, 150°C Through 250°C (302°F Through 482°F).~~ Not More Than Three Current-Carrying Conductors in Raceway or Cable ~~, Based on Ambient Air Temperature of 40°C (104°F)*~~

Size AWG or kcmil	Temperature Rating of Conductor [See Table 310.~~10~~4(A)~~.~~]				Size AWG or kcmil
	150°C (302°F)	200°C (392°F)	250°C (482°F)	150°C (302°F)	
	Type Z	Types FEP, FEPB, PFA, SA	Types PFAH, TFE	Type Z	
	COPPER		NICKEL OR NICKEL-COATED COPPER	ALUMINUM OR COPPER-CLAD ALUMINUM	
14	34	36	39	—	14
12	43	45	54	30	12
10	55	60	73	44	10
8	76	83	93	57	8
6	96	110	117	75	6
4	120	125	148	94	4
3	143	152	166	109	3
2	160	171	191	124	2
1	186	197	215	145	1
1/0	215	229	244	169	1/0
2/0	251	260	273	198	2/0
3/0	288	297	308	227	3/0
4/0	332	346	361	260	4/0

Notes:
~~Refer to~~ Section 310.18 shall be referenced for conditions of use.
~~*Refer to~~ Section 310.15(B)~~(2)~~ shall be referenced for the ampacity correction factors where the ambient temperature is other than 40°C (104°F).
~~Refer to~~ Section 310.15~~(C)(1)(B)(3)(a)~~ shall be referenced for more than three current-carrying conductors.

Commented [CK5]: Table notes should be mandatory

~~Table 310.15(B)(19) (formerly~~ Table 310.19~~)~~ ~~Allowable~~ Ampacities of Single-Insulated Conductors~~, Rated Up to and Including 2000 Volts, 150°C Through 250°C (302°F Through 482°F),~~ in Free Air~~, Based on Ambient Air Temperature of 40°C (104°F)*~~

Size AWG or kcmil	Temperature Rating of Conductor [See Table 310.~~10~~4(A)~~.~~]				Size AWG or kcmil
	150°C (302°F)	200°C (392°F)	250°C (482°F)	150°C (302°F)	
	Type Z	Types FEP, FEPB, PFA, SA	Types PFAH, TFE	Type Z	
	COPPER		NICKEL, OR NICKEL-COATED COPPER	ALUMINUM OR COPPER-CLAD ALUMINUM	
14	46	54	59	—	14
12	60	68	78	47	12
10	80	90	107	63	10
8	106	124	142	83	8
6	155	165	205	112	6
4	190	220	278	148	4
3	214	252	327	170	3
2	255	293	381	198	2
1	293	344	440	228	1
1/0	339	399	532	263	1/0
2/0	390	467	591	305	2/0
3/0	451	546	708	351	3/0
4/0	529	629	830	411	4/0

Notes:

~~Refer to~~ Section 310.19 shall be referenced for conditions of use.

~~*Refer to~~ Section 310.15(B)~~(2)~~ shall be referenced for the ampacity correction factors where the ambient temperature is other than 40°C (104°F).

~~Table 310.15(B)(20) (formerly~~ Table 310.20~~)~~ Ampacities of Conductors~~s of Not More Than Three Single Insulated Conductors, Rated Up to and Including 2000 Volts,~~ Supported on a Messenger~~, Based on Ambient Air Temperature of 40°C (104°F)*~~

Size AWG or kcmil	Temperature Rating of Conductor [See Table 310.~~10~~4(A).]				Size AWG or kcmil
	75°C (167°F)	90°C (194°F)	75°C (167°F)	90°C (194°F)	
	Types RHW, THHW, THW, THWN, XHHW, XHWN, ZW	Types MI, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHHW, XHHW-2, XHWN, XHWN-2, ZW-2	Types RHW, THW, THWN, THHW, XHHW, XHWN	Types THHN, THHW, RHH, XHHW, RHW-2, XHHW-2, XHWN, XHWN-2, THW-2, THWN-2, USE-2, ZW-2	
	COPPER		ALUMINUM OR COPPER-CLAD ALUMINUM		
8	57	66	44	51	8
6	76	89	59	69	6
4	101	117	78	91	4
3	118	138	92	107	3
2	135	158	106	123	2
1	158	185	123	144	1
1/0	183	214	143	167	1/0
2/0	212	247	165	193	2/0

Size AWG or kcmil	Temperature Rating of Conductor [See Table 310.~~10~~4(A).]				Size AWG or kcmil
	75°C (167°F)	90°C (194°F)	75°C (167°F)	90°C (194°F)	
	Types RHW, THHW, THW, THWN, XHHW, XHWN, ZW	Types MI, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHHW, XHHW-2, XHWN, XHWN-2, ZW-2	Types RHW, THW, THWN, THHW, XHHW, XHWN	Types THHN, THHW, RHH, XHHW, RHW-2, XHHW-2, XHWN, XHWN-2, THW-2, THWN-2, USE-2, ZW-2	
	COPPER		ALUMINUM OR COPPER-CLAD ALUMINUM		
3/0	245	287	192	224	3/0
4/0	287	335	224	262	4/0
250	320	374	251	292	250
300	359	419	282	328	300
350	397	464	312	364	350
400	430	503	339	395	400
500	496	580	392	458	500
600	553	647	440	514	600
700	610	714	488	570	700
750	638	747	512	598	750
800	660	773	532	622	800
900	704	826	572	669	900
1000	748	879	612	716	1000

Notes:
~~Refer to~~ Section 310.20 shall be referenced for conditions of use.
~~*Refer to~~ Section 310.15(B)~~(2)~~ shall be referenced for the ampacity correction factors where the ambient temperature is other than 40°C (104°F).
~~Refer to~~ Section 310.15~~(C)(1)(B)(3)(a)~~ shall be referenced for more than three current-carrying conductors.

~~Table 310.15(B)(21) (formerly~~ **Table 310.21** ~~)~~ **Ampacities of Bare or Covered Conductors in Free Air~~, Based on 40°C (104°F) Ambient, 80°C (176°F) Total Conductor Temperature, 610 mm/sec (2 ft/sec) Wind Velocity~~**

Copper Conductors				AAC Aluminum Conductors			
Bare		Covered		Bare		Covered	
AWG or kcmil	Amperes	AWG or kcmil	Amperes	AWG or kcmil	Amperes	AWG or kcmil	Amperes
8	98	8	103	8	76	8	80
6	124	6	130	6	96	6	101
4	155	4	163	4	121	4	127
2	209	2	219	2	163	2	171
1/0	282	1/0	297	1/0	220	1/0	231
2/0	329	2/0	344	2/0	255	2/0	268
3/0	382	3/0	401	3/0	297	3/0	312
4/0	444	4/0	466	4/0	346	4/0	364
250	494	250	519	266.8	403	266.8	423
300	556	300	584	336.4	468	336.4	492
500	773	500	812	397.5	522	397.5	548
750	1000	750	1050	477.0	588	477.0	617

Copper Conductors				AAC Aluminum Conductors			
Bare		Covered		Bare		Covered	
AWG or kcmil	Amperes	AWG or kcmil	Amperes	AWG or kcmil	Amperes	AWG or kcmil	Amperes
1000	1193	1000	1253	556.5	650	556.5	682
—	—	—	—	636.0	709	636.0	744
—	—	—	—	795.0	819	795.0	860
—	—	—	—	954.0	920	—	—
—	—	—	—	1033.5	968	1033.5	1017
—	—	—	—	1272	1103	1272	1201
—	—	—	—	1590	1267	1590	1381
—	—	—	—	2000	1454	2000	1527

Note:
~~Refer to~~ Section 310.21 shall be referenced for conditions of use.

Commented [CK6]: Table notes should be mandatory

[310.60 moving to Article 311]

First Revision No. 8036-NFPA 70-2018 [Global Input]

Insert New Article 337

Article 337 **Type P**

Part I. **General**

337.1 **Scope.**

This article covers the use, installation, and construction specifications for 600 volt Type P cable (armored and unarmored), for use in hazardous (classified) locations as permitted in this *Code*.

337.2 **Definition.**

The definition in this section shall apply within this article and throughout the *Code*.

Type P.

A factory assembly of two or more insulated flexible tinned copper conductors, with associated bare or covered grounding conductors, impervious sheath, braided metallic armored or unarmored cable. See Part III.

337.6 **Listing Requirements.**

Type P cables and associated fittings shall be listed.

Part II. **Installation**

337.10 **Uses Permitted.**

In industrial locations under engineering supervision where the conditions of maintenance and supervision ensure that only qualified persons service the installation, Type P cable shall be permitted for use in hazardous (classified) locations and to transition between a hazardous (classified) location and a non-hazardous (classified) location as follows:

(1) For services, feeders, and branch circuits

(2) For power, lighting, control, and signal circuits

(3) Indoors

(4) Outdoors where identified for such use

(5) Exposed or concealed

(6) For direct burial where identified for such use

(7) In cable tray where identified for such use

(8) In any raceway

(9) In wet locations

(10) Between a cable tray and the utilization equipment or device(s), provided all of the following apply:

a. The cable is installed in industrial establishments where the conditions of maintenance and supervision ensure that only qualified persons service the installation.

b. The cable is continuously supported and protected against physical damage using mechanical protection such as struts, angles, or channels.

c. The cable is secured at intervals not exceeding 1.4 m (4.5 ft).

d. Equipment grounding for the utilization equipment is provided by a bare equipment grounding conductor within the cable.

Exception to (10): Where not subject to physical damage, Type P shall be permitted to transition between cable trays and between cable trays and utilization equipment or devices for a distance not to exceed 1.8 m (6 ft) without continuous support. The cable shall be mechanically supported where exiting the cable tray to ensure that the minimum bending radius is not exceeded.

337.12 **Uses Not Permitted.**

Type P cable shall not be installed or used where it will be exposed to physical damage.

337.24 **Bending Radius.**

Bends in Type P cable shall be made such that the cable will not be damaged. The radius of the curve of the inner edge of any bend shall not be less than required in 337.24(A) through (B).

(A) **Unarmored Cable.**

(1) Four times the overall diameter for cables 25 mm (1 in.) or less in diameter

(2) Five times the overall diameter for cables larger than 25 mm (1 in.) but not more than 50 mm (2 in.) in diameter

(3) Six times the overall diameter for cables larger than 50 mm (2 in.) in diameter

(B) **Armored Cable.**

(1) Ten times the external diameter of the metallic armor for cable not more than 19 mm (3⁄4 in.) in external diameter

(2) Twelve times the external diameter of the metallic armor for cable more than 19 mm (3⁄4 in.) in external diameter

337.30 **Securing and Supporting.**

Type P cable shall be supported and secured by cable ties listed and identified for securement and support; straps, hangers, or similar fittings; or other approved means designed and installed so as not to damage the cable.

(A) **Securing.**

Unless otherwise provided, cables shall be secured at intervals not exceeding 1.4 m (4.5 ft). Cables containing four or fewer conductors sized no larger than 10 AWG shall be secured within 300 mm (12 in.) of every box, cabinet, fitting, or other cable termination. In vertical installations, cables with ungrounded conductors 250 kcmil and larger shall be permitted to be secured at intervals not exceeding 3 m (10 ft.).

(B) **Supporting.**

Unless otherwise provided, cables shall be supported at intervals not exceeding 1.4 m (4.5 ft). Horizontal runs of Type P cable installed in wooden or metal framing members or similar supporting means shall be considered supported and secured where such support does not exceed 1.4 m (4.5 ft) intervals.

(C) **Unsupported Cables.**

Type P cable shall be permitted to be unsupported and unsecured where the cable complies with any of the following:

(1) Is fished between access points through concealed spaces in finished buildings or structures and supporting is impractical

(2) Is not more than 1.4 m (4.5 ft) in length from the last point of cable support to the point of connection to luminaires or other electrical equipment and the cable and point of connection are within an accessible ceiling

(3) Is in lengths not exceeding 900 mm (3 ft) from the last point where it is securely fastened and is used to connect equipment where flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation

337.31 **Single Conductors.**

Where single-conductor cables are used, the installation shall comply with 300.20.

337.80 **Ampacity.**

The ampacity of Type P cable shall be determined in accordance with 310.15 for 14 AWG and larger conductors and in accordance with Table 402.5 for 18 AWG and 16 AWG conductors. When installed in cable tray, the ampacities shall be determined in accordance with 392.80. The installation shall not exceed the temperature ratings of terminations and equipment.

Part III. **Construction Specifications**

337.104 **Conductors.**

Conductors shall be of tinned copper. Conductors shall employ flexible stranding. The minimum conductor size shall be 18 AWG.

337.108 **Equipment Grounding Conductor.**

An equipment grounding conductor complying with 250.122 shall be provided within the cable.

An uninsulated equipment grounding conductor shall be provided in cable marked Type P-HL.

337.112 **Insulation.**

Insulated conductors shall comply with 337.112(A) or (B).

Insulated conductors in sizes 18 AWG and 16 AWG shall be Type FFHH-2 as listed in Table 402.3. Conductors larger than 16 AWG shall be Type XHHW or XHHW-2 as listed in Table 310.4(A).

337.116 **Sheath.**

The sheath or outer covering shall comply with 337.116(A) or (B).

(A) **Armored.**

An overall nonmetallic jacket impervious to moisture and corrosion-resistant shall be provided over the armor. The armor or metallic covering shall be a braided basket weave type consisting of wire laid closely together, flat and parallel, and forming a basket weave that shall firmly grip the cable. The wire shall be commercial bronze. The armor shall not be used as a current-carrying conductor.

(B) **Unarmored.**

An overall flame-retardant, nonmetallic material impervious to moisture and corrosion-resistant shall be provided over the cable core. A metallic sheath or armor as defined in 337.116 shall not be permitted either under or over the nonmetallic jacket. Metallic shield(s) shall be permitted over groups of conductors, under the outer jacket, or both.

337.120 **Marking.**

Type P cable shall be marked in accordance with 310.8. Armored cable shall be marked as Type P-HL.

Supplemental Information

File Name	Description	Approved
New_Article_337.docx	New Article 337--for staff use	✓

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jan 12 00:36:35 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Type P (IEEE-1580/UL-1309) Marine Shipboard Cable is flexible and rugged and is highly suitable for petrochemical applications and oil and gas well drilling land based rigs because of its ability to resist various chemicals, abrasives, and petroleum based additives as well as its ability to resist damage from vibration, shaking, and movement that occurs in many processes have a long successful history of more than 4 decades in installations in the most adverse conditions.

They are particularly applicable to land based oil and gas well drilling where units are often “rigged down” and transported and where rigid conduit and Type MC-HL cables are not suitable.

These cables are also available with a metallic basket-weave braided armor that effectively enhances their durability, and for use in Division 1 and Zone 1 applications.

Based on cable performance and requirements for some land based operations, this cable type has been proposed to be added to the 2020 NEC for hazardous area applications.

Response Message:

Public Input No. 4309-NFPA 70-2017 [New Article after 336]

Editorial Comment

Click here

First Revision No. 8331-NFPA 70-2018 [Detail]

Chapter 9, Table 5A

Table 5A Compact Copper and Aluminum Building Wire Nominal Dimensions and Areas**

Size (AWG or kcmil)	Bare Conductor		Types RHH**, RHW**, or USE				Types THW and THHW				Type T	
	Diameter		Approximate Diameter		Approximate Area		Approximate Diameter		Approximate Area		Approximate Diameter	
	mm	in.	mm	in.	mm^2	$in.^2$	mm	in.	mm^2	$in.^2$	mm	in.
8	3.404	0.134	6.604	0.260	34.25	0.0531	6.477	0.255	32.90	0.0510	—	—
6	4.293	0.169	7.493	0.295	44.10	0.0683	7.366	0.290	42.58	0.0660	6.096	0.240
4	5.410	0.213	8.509	0.335	56.84	0.0881	8.509	0.335	56.84	0.0881	7.747	0.305
2	6.807	0.268	9.906	0.390	77.03	0.1194	9.906	0.390	77.03	0.1194	9.144	0.360
1	7.595	0.299	11.81	0.465	109.5	0.1698	11.81	0.465	109.5	0.1698	10.54	0.415
1/0	8.534	0.336	12.70	0.500	126.6	0.1963	12.70	0.500	126.6	0.1963	11.43	0.450
2/0	9.550	0.376	13.72	0.540	147.8	0.2290	13.84	0.545	150.5	0.2332	12.57	0.495
3/0	10.74	0.423	14.99	0.590	176.3	0.2733	14.99	0.590	176.3	0.2733	13.72	0.540
4/0	12.07	0.475	16.26	0.640	207.6	0.3217	16.38	0.645	210.8	0.3267	15.11	0.595
250	13.21	0.520	18.16	0.715	259.0	0.4015	18.42	0.725	266.3	0.4128	17.02	0.670
300	14.48	0.570	19.43	0.765	296.5	0.4596	19.69	0.775	304.3	0.4717	18.29	0.720
350	15.65	0.616	20.57	0.810	332.3	0.5153	20.83	0.820	340.7	0.5281	19.56	0.770
400	16.74	0.659	21.72	0.855	370.5	0.5741	21.97	0.865	379.1	0.5876	20.70	0.815
500	18.69	0.736	23.62	0.930	438.2	0.6793	23.88	0.940	447.7	0.6939	22.48	0.885
600	20.65	0.813	26.29	1.035	542.8	0.8413	26.67	1.050	558.6	0.8659	25.02	0.985
700	22.28	0.877	27.94	1.100	613.1	0.9503	28.19	1.110	624.3	0.9676	26.67	1.050
750	23.06	0.908	28.83	1.135	652.8	1.0118	29.21	1.150	670.1	1.0386	27.31	1.075
900	25.37	0.999	31.50	1.240	779.3	1.2076	31.09	1.224	759.1	1.1766	30.33	1.194
1000	26.92	1.060	32.64	1.285	836.6	1.2968	32.64	1.285	836.6	1.2968	31.88	1.255

** Types RHH and RHW without outer coverings .

** Dimensions are from industry sources.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06

Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jan 16 10:20:32 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Changed the Asterisks to reflect the reordered references below the table.
Response Message:

Public Input No. 606-NFPA 70-2017 [Section No. Table]

Editorial Comment

Click here

First Revision No. 8918-NFPA 70-2018 [Detail]

******Relocate 310.15(B)(3)(C) and insert after the formula under "Ambient Temperature Correction Factors"******

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jan 22 13:31:01 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Relocate text from 310.15(B)(3)(c) to this section relating to temperature correction.

Response Message:

Public Input No. 1525-NFPA 70-2017 [Section No. 310.15(B)(2)]

Public Input No. 1524-NFPA 70-2017 [Section No. 310.15(B)(3)]

First Revision No. 7860-NFPA 70-2018 [Definition: Copper-Clad Aluminum Conductors.]

Copper-Clad Aluminum Conductors.

Conductors drawn from a copper-clad aluminum rod, with the copper metallurgically bonded to an aluminum core~~, where the copper forms a minimum of 10 percent of the cross-sectional area of a solid conductor or each strand of a stranded conductor~~ . (CMP-6)

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 16:27:18 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Section 2.3.2.1 of the NFPA Manual of style states that definitions shall only describe the term being used and section 2.3.2.3 states that definitions shall not contain requirements. The present definition contains a requirement that the copper-clad aluminum have a minimum 10 percent of the cross-sectional area being copper.

Response Message:

Public Input No. 2110-NFPA 70-2017 [Definition: Copper-Clad Aluminum Conductors.]

First Revision No. 7864-NFPA 70-2018 [New Definition after Definition: Luminaire.]

Messenger or Messenger Wire.

A wire that is run integral with or parallel to a cable or conductor to provide mechanical support for the cable or conductor. (CMP-6)

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 16:45:01 EST 2018

Committee Statement and Meeting Notes

Committee Statement: The term 'Messenger Supported Wiring' is defined in Article 396, however, the term 'messenger and messenger wire' are used as stand-alone terms. Therefore, a definition is needed in Article 100.

Response Message:

Public Input No. 340-NFPA 70-2017 [New Definition after Definition: Luminaire.]

Editorial Comment

Click here

First Revision No. 7873-NFPA 70-2018 [Section No. 320.2]

320.2 Definition.

The definition in this section shall apply within this article and throughout the *Code* .

Armored Cable, Type AC.

A fabricated assembly of insulated conductors in a flexible interlocked metallic armor. See 320.100.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 17:02:08 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Language was added based on the recommendation of the Correlating Committee task group on definitions to improve usability.

Response Message:

Public Input No. 2182-NFPA 70-2017 [Section No. 320.2]

Editorial Comment

Click here

First Revision No. 7874-NFPA 70-2018 [Section No. 320.15]

320.15 Exposed Work.

Exposed runs of cable, except as provided in ~~300.11(A)~~ 300.11(B) , shall closely follow the surface of the building finish or of running boards. Exposed runs shall also be permitted to be installed on the underside of joists where supported at each joist and located so as not to be subject to physical damage.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 17:03:49 EST 2018

Committee Statement and Meeting Notes

Committee Statement: 300.11 was revised in the 2017 cycle. Therefore the reference was updated.
Response Message:

Public Input No. 350-NFPA 70-2017 [Section No. 320.15]

First Revision No. 7876-NFPA 70-2018 [Section No. 320.23(A)]

(A) Cables Run Across the Top of Floor Joists.

Where run across the top of floor joists, or within 2.1 m (7 ft) of the floor or floor joists across the face of rafters or studding, the cable shall be protected by guard strips that are at least as high as the cable. Where this space is not accessible by ~~permanent~~ permanently installed stairs or ladders, protection shall only be required within 1.8 m (6 ft) of the nearest edge of the scuttle hole or attic entrance.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 17:05:14 EST 2018

Committee Statement and Meeting Notes

Committee Statement: 'Fixed in place' is not permanently mounted and stairs that are fixed in place could be removed. Revising the wording to indicate 'permanently installed'clarifies the text.

Response Message:

Public Input No. 179-NFPA 70-2017 [Section No. 320.23(A)]

First Revision No. 7877-NFPA 70-2018 [Section No. 320.30(C)]

(C) Supporting.

Unless otherwise permitted, Type AC cable shall be supported at intervals not exceeding 1.4 m (4½ ft).

Horizontal runs of Type AC cable installed in wooden or metal framing members or similar supporting means shall be considered supported and secured where such support does not exceed 1.4 m (4½ ft) intervals.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 17:08:45 EST 2018

Committee Statement and Meeting Notes

Committee Statement: To maintain consistency with supporting of similar cable types (MC cables), the wording is revised to include securement of AC cables.

Response Message:

Public Input No. 449-NFPA 70-2017 [Section No. 320.30(C)]

Public Input No. 1534-NFPA 70-2017 [Section No. 320.30(C)]

First Revision No. 7866-NFPA 70-2018 [Section No. 322.2]

322.2 Definition.

The definition in this section shall apply within this article and throughout the *Code* .

Flat Cable Assembly, Type FC.

An assembly of parallel conductors formed integrally with an insulating material web specifically designed for field installation in surface metal raceway.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 16:52:02 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Language was added based on the recommendation of the Correlating Committee task group on definitions to improve usability.

Response Message:

Public Input No. 2183-NFPA 70-2017 [Section No. 322.2]

Editorial Comment

Click here

First Revision No. 7871-NFPA 70-2018 [Section No. 324.2]

324.2 Definitions.

The definitions in this section shall apply only within this article.

Bottom Shield.

A protective layer that is installed between the floor and Type FCC flat conductor cable to protect the cable from physical damage and may or may not be incorporated as an integral part of the cable.

Cable Connector.

A connector designed to join Type FCC cables without using a junction box.

FCC System.

A complete wiring system for branch circuits that is designed for installation under carpet squares.

Informational Note: The FCC system includes Type FCC cable and associated shielding, connectors, terminators, adapters, boxes, and receptacles.

Insulating End.

An insulator designed to electrically insulate the end of a Type FCC cable.

Metal Shield Connections.

Means of connection designed to electrically and mechanically connect a metal shield to another metal shield, to a receptacle housing or self-contained device, or to a transition assembly.

Top Shield.

A grounded metal shield covering under-carpet components of the FCC system for the purposes of providing protection against physical damage.

Transition Assembly.

An assembly to facilitate connection of the FCC system to other wiring systems, incorporating (1) a means of electrical interconnection and (2) a suitable box or covering for providing electrical safety and protection against physical damage.

Type FCC Cable.

Three or more flat copper conductors placed edge-to-edge and separated and enclosed within an insulating assembly.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 16:57:47 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Language was added based on the recommendation of the Correlating Committee task group on definitions to improve usability.
Response Message:

Public Input No. 1209-NFPA 70-2017 [Section No. 324.2]

Editorial Comment

Click here

First Revision No. 7872-NFPA 70-2018 [Section No. 324.42(A)]

(A) Receptacles.

All receptacles, receptacle housings, and self-contained devices used with the FCC system shall be identified for this use and shall be connected to the Type FCC cable and metal shields. Connection from any equipment grounding conductor of the Type FCC cable shall be made to the shield system at each receptacle.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 16:59:36 EST 2018

Committee Statement and Meeting Notes

Committee Statement: The revised text uses terms defined in the Code and is consistent with the context of the meaning of the

section where the revisions are made. The revisions are made to provide clarity, and consistency in terminology usage.

Response Message:

Public Input No. 2376-NFPA 70-2017 [Section No. 324.42(A)]

Public Input No. 3325-NFPA 70-2017 [Section No. 324.42(A)]

First Revision No. 7868-NFPA 70-2018 [Section No. 326.2]

326.2 Definition.

The definition in this section shall apply within this article and throughout the *Code* .

Integrated Gas Spacer Cable, Type IGS.

A factory assembly of one or more conductors, each individually insulated and enclosed in a loose fit, nonmetallic flexible conduit as an integrated gas spacer cable rated 0 volts through 600 volts.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 16:54:00 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Language was added based on the recommendation of the Correlating Committee task group on definitions to improve usability.

Response Message:

Public Input No. 2184-NFPA 70-2017 [Section No. 326.2]

Editorial Comment

Click here

First Revision No. 7879-NFPA 70-2018 [Section No. 330.2]

330.2 Definition.

The definition in this section shall apply within this article and throughout the *Code* .

Metal Clad Cable, Type MC.

A factory assembly of one or more insulated circuit conductors with or without optical fiber members enclosed in an armor of interlocking metal tape, or a smooth or corrugated metallic sheath.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 17:09:57 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Language was added based on the recommendation of the Correlating Committee task group on definitions to improve usability.

Response Message:

Public Input No. 2186-NFPA 70-2017 [Section No. 330.2]

Editorial Comment

Click here

First Revision No. 7885-NFPA 70-2018 [Section No. 330.15]

330.15 Exposed Work.

Exposed runs of cable, except as provided in ~~300.11(A)~~ 300.11(B) , shall closely follow the surface of the building finish or of running boards. Exposed runs shall also be permitted to be installed on the underside of joists where supported at each joist and located so as not to be subject to physical damage.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 17:29:29 EST 2018

Committee Statement and Meeting Notes

Committee Statement: 300.11 was revised in the 2017 cycle. Therefore the reference was updated to reflect the correct references.

Response Message:

Public Input No. 351-NFPA 70-2017 [Section No. 330.15]

Public Input No. 3246-NFPA 70-2017 [Section No. 330.15]

First Revision No. 7870-NFPA 70-2018 [Section No. 332.2]

332.2 Definition.

The definition in this section shall apply within this article and throughout the *Code* .

Mineral-Insulated, Metal-Sheathed Cable, Type MI.

A factory assembly of one or more conductors insulated with a highly compressed refractory mineral insulation and enclosed in a liquidtight and gastight continuous copper or alloy steel sheath.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 16:56:19 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Language was added based on the recommendation of the Correlating Committee task group on definitions to improve usability.

Response Message:

Public Input No. 2187-NFPA 70-2017 [Section No. 332.2]

Editorial Comment

Click here

First Revision No. 8005-NFPA 70-2018 [Section No. 334.6]

334.6 Listing Requirements.

Type NM~~,~~ and Type NMC~~, and Type NMS~~ cables and associated fittings shall be listed.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jan 11 16:53:53 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Type NMS cable construction is not manufactured.
Response Message:

Public Input No. 4000-NFPA 70-2017 [Section No. 334.6]

First Revision No. 8045-NFPA 70-2018 [Section No. 334.12]

334.12 Uses Not Permitted.

(A) Types NM~~,~~ and NMC~~, and NMS~~ .

Types NM~~,~~ and NMC~~, and NMS~~ cables shall not be permitted as follows:

(1) In any dwelling or structure not specifically permitted in 334.10(1), (2), (3), and (5)

(2) Exposed within a dropped or suspended ceiling cavity in other than one- and two-family and multifamily dwellings

(3) As service-entrance cable

(4) In commercial garages having hazardous (classified) locations as defined in 511.3

(5) In theaters and similar locations, except where permitted in 518.4(B)

(6) In motion picture studios

(7) In storage battery rooms

(8) In hoistways or on elevators or escalators

(9) Embedded in poured cement, concrete, or aggregate

(10) In hazardous (classified) locations, except where specifically permitted by other articles in this *Code*

(B) ~~Types~~ Type NM ~~and NMS~~ .

~~Types~~ Type NM ~~and NMS~~ cables shall not be used under the following conditions or in the following locations:

(1) Where exposed to corrosive fumes or vapors

(2) Where embedded in masonry, concrete, adobe, fill, or plaster

(3) In a shallow chase in masonry, concrete, or adobe and covered with plaster, adobe, or similar finish

(4) In wet or damp locations

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jan 12 08:17:10 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Type NMS cable construction is not manufactured and should have been deleted along with Article 780 in the 2008 NEC.

Response Message:

Public Input No. 4012-NFPA 70-2017 [Section No. 334.12]

First Revision No. 8046-NFPA 70-2018 [Section No. 334.15 [Excluding any Sub-Sections]]

In exposed work, except as provided in ~~300.11(A)~~ 300.11(B) , cable shall be installed as specified in 334.15(A) through (C).

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jan 12 08:18:39 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Section 300.11 was renumbered in 2017 revision to the NEC. Section 334.15 is being revised to reflect the correct reference which is 300.11(B)

Response Message:

Public Input No. 352-NFPA 70-2017 [Section No. 334.15 [Excluding any Sub-Sections]]

First Revision No. 8047-NFPA 70-2018 [Section No. 334.17]

334.17 Through or Parallel to Framing Members.

Types NM~~,~~ and NMC~~, or NMS~~ cable shall be protected in accordance with 300.4 where installed through or parallel to framing members. Grommets used as required in 300.4(B)(1) shall remain in place and be listed for the purpose of cable protection.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jan 12 08:19:15 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Type NMS cable construction is not manufactured and should have been deleted along with Article 780 in the 2008 NEC.

Response Message:

Public Input No. 4014-NFPA 70-2017 [Section No. 334.17]

First Revision No. 8048-NFPA 70-2018 [Section No. 334.24]

334.24 Bending Radius.

Bends in Types NM~~, NMC, and NMS~~ and NMC cable shall be so made that the cable will not be damaged. The radius of the curve of the inner edge of any bend during or after installation shall not be less than five times the diameter of the cable.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jan 12 08:20:10 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Type NMS cable construction is not manufactured and should have been deleted along with Article 780 in the 2008 NEC.

Response Message:

Public Input No. 4016-NFPA 70-2017 [Section No. 334.24]

First Revision No. 8049-NFPA 70-2018 [Section No. 334.30 [Excluding any Sub-Sections]]

Nonmetallic-sheathed cable shall be supported and secured by staples, cable ties listed and identified for securement and support, or straps, hangers, or similar fittings designed and installed so as not to damage the cable, at intervals not exceeding 1.4 m (4½ ft) and within 300 mm (12 in.) of every cable measured no more than 450 mm (18 in.) along the cable sheath, entry into enclosures such as outlet boxes, junction boxes, cabinets, or fittings. Flat cables shall not be stapled on edge.

Sections of cable protected from physical damage by raceway shall not be required to be secured within the raceway.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jan 12 08:23:25 EST 2018

Committee Statement and Meeting Notes

Committee Statement: The current requirements permits unlimited lengths of cable to be unsecured from the last point of attachment. The extra length will provide conductor length for repair.

Response Message:

Public Input No. 3492-NFPA 70-2017 [Section No. 334.30 [Excluding any Sub-Sections]]

Public Input No. 2165-NFPA 70-2017 [Section No. 334.30 [Excluding any Sub-Sections]]

Editorial Comment

Click here

First Revision No. 8050-NFPA 70-2018 [Section No. 334.80]

334.80 Ampacity.

The ampacity of Types NM~~,~~ and NMC~~, and NMS~~ cable shall be determined in accordance with 310.14. The ~~allowable~~ ampacity shall not exceed that of a 60°C (140°F) rated conductor. The 90°C (194°F) rating shall be permitted to be used for ampacity adjustment and correction calculations, provided the final calculated ampacity does not exceed that of a 60°C (140°F) rated conductor. The ampacity of Types NM~~,~~ and NMC~~, and NMS~~ cable installed in cable trays shall be determined in accordance with 392.80(A).

Where more than two NM cables containing two or more current-carrying conductors are installed, without maintaining spacing between the cables, through the same opening in wood framing that is to be sealed with thermal insulation, caulk, or sealing foam, the ~~allowable~~ ampacity of each conductor shall be adjusted in accordance with Table 310.15(C)(1) and the provisions of 310.14(A)(2), Exception, shall not apply.

Where more than two NM cables containing two or more current-carrying conductors are installed in contact with thermal insulation without maintaining spacing between cables, the ~~allowable~~ ampacity of each conductor shall be adjusted in accordance with Table 310.15(C)(1).

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jan 12 08:37:23 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Type NMS cable construction is not manufactured and should have been deleted along with Article 780 in the 2008 NEC.

Ampacity is the maximum current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating. The term used in this section should be "ampacity" and not "allowable ampacity" as it is the intent for this section to determine the ampacity of the conductor based upon its condition of use.

Response Message:

Public Input No. 4017-NFPA 70-2017 [Section No. 334.80]

Public Input No. 933-NFPA 70-2017 [Section No. 334.80]

First Revision No. 8051-NFPA 70-2018 [Section No. 334.104]

334.104 Conductors.

The 600-volt insulated power conductors shall be sizes 14 AWG through 2 AWG copper conductors or sizes 12 AWG through 2 AWG aluminum or copper-clad aluminum conductors. ~~The communications conductors shall comply with Part V of Article 800 .~~ Control and signaling conductors shall be no smaller than 18 AWG copper.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jan 12 08:41:19 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Communication language was deleted to reflect the deletion of Type NMS. Control and Signaling conductors were added to provide minimum conductor sizes for these applications.

Response Message:

Public Input No. 3953-NFPA 70-2017 [Section No. 334.104]

First Revision No. 8053-NFPA 70-2018 [Section No. 334.116(C)]

~~**(C)** Type NMS.~~

~~The overall covering shall be flame retardant and moisture resistant. The sheath shall be applied so as to separate the power conductors from the communications conductors.~~

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jan 12 08:43:52 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Type NMS cable construction is not manufactured and should have been deleted along with Article 780 in the 2008 NEC.

Response Message:

Public Input No. 3959-NFPA 70-2017 [Section No. 334.116(C)]

First Revision No. 7676-NFPA 70-2018 [Section No. 336.80]

336.80 Ampacity.

The ampacity of Type TC tray cable shall be determined in accordance with 392.80(A) for 14 AWG and larger conductors, in accordance with 402.5 for 18 AWG through 16 AWG conductors where installed in cable trays , and in accordance with 310.14 where installed ~~in a raceway or as messenger-supported wiring~~ outside of cable trays, where permitted .

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jan 09 14:38:31 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Anything outside of cable tray should be subject to the ampacity requirements in Article 310.

Response Message:

Public Input No. 4261-NFPA 70-2017 [Section No. 336.80]

Editorial Comment

Click here

First Revision No. 7950-NFPA 70-2018 [Section No. 338.100]

338.100 Construction.

(A)

Cabled~~,~~ assemblies of multiple single-conductor~~,~~ Type USE ~~constructions recognized for underground use~~ conductors shall be permitted ~~to have a bare copper conductor cabled with the assembly. Type USE single, parallel, or cabled conductor assemblies recognized for underground use shall be permitted to have a bare copper concentric conductor applied. These constructions shall not require an outer overall covering.~~ for direct burial. All conductors shall be insulated.

Informational Note: ~~See 230.41 , Exception, item (2), for directly buried, uninsulated service-entrance conductors.~~ The term “cabled” refers to a manufacturing process of twisting single conductors together and may also be referred to as “plexed.”

(B)

Type SE or USE cable with an overall covering containing two or more conductors shall be permitted to have one conductor uninsulated.

Supplemental Information

File Name	Description	Approved
Panel_6_FR-7950_338.100_leg_changes.docx	For staff use	✓

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jan 11 11:57:48 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Due to concerns for corrosion the allowance for use of a bare conductor was removed.

Response Message:

Public Input No. 3748-NFPA 70-2017 [Section No. 338.100]

First Revision No. 7765-NFPA 70-2018 [Section No. 340.2]

340.2 Definition.

The definition in this section shall apply within this article and throughout the *Code* .

Underground Feeder and Branch-Circuit Cable, Type UF.

A factory assembly of one or more insulated conductors with an integral or an overall covering of nonmetallic material suitable for direct burial in the earth.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 08:36:50 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Language was added based on the recommendation of the Correlating Committee task group on definitions to improve usability.

Response Message:

Public Input No. 2191-NFPA 70-2017 [Section No. 340.2]

Editorial Comment

Click here

First Revision No. 7696-NFPA 70-2018 [Section No. 382.2]

382.2 Definitions.

The definitions in this section shall apply within this article and throughout the *Code* .

Concealable Nonmetallic Extension.

A listed assembly of two, three, or four insulated circuit conductors within a nonmetallic jacket, an extruded thermoplastic covering, or a sealed nonmetallic covering. The classification includes surface extensions intended for mounting directly on the surface of walls or ceilings~~,~~ and concealed with paint, texture, joint compound, plaster, wallpaper, tile, wall paneling, or other similar materials.

Nonmetallic Extension.

An assembly of two insulated conductors within a nonmetallic jacket or an extruded thermoplastic covering. The classification includes surface extensions intended for mounting directly on the surface of walls or ceilings.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jan 09 16:10:42 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Language was added based on the recommendation of the Correlating Committee task group on definitions to improve usability.

Response Message:

Public Input No. 2217-NFPA 70-2017 [Section No. 382.2]

Editorial Comment

Click here

First Revision No. 7697-NFPA 70-2018 [Section No. 382.100]

382.100 Construction.

Concealable nonmetallic extensions shall be of a multilayer flat conductor design consisting of a center ungrounded conductor enclosed by a sectioned grounded conductor, and an overall sectioned equipment grounding conductor.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jan 09 16:12:29 EST 2018

Committee Statement and Meeting Notes

Committee Statement: The revision incorporates terms into this section to clarify what conductors this definition is intended to apply to.

Response Message:

Public Input No. 2391-NFPA 70-2017 [Section No. 382.100]

Public Input No. 3329-NFPA 70-2017 [Section No. 382.100]

Editorial Comment

Click here

First Revision No. 7699-NFPA 70-2018 [Section No. 382.104]

382.104 Flat Conductors.

Concealable nonmetallic extensions shall be constructed, using flat copper conductors equivalent to 14 AWG or 12 AWG conductor sizes, and constructed per 382.104(A), (B), and (C).

(A) Ungrounded Conductor (Center Layer).

The ungrounded conductor shall consist of one or more ungrounded flat conductor(s) enclosed in accordance with 382.104(B) and (C) and identified in accordance with 310.6(C).

(B) Grounded Conductor (Inner Sectioned Layers).

The grounded conductor shall consist of two sectioned inner flat conductors that enclose the center ungrounded conductor(s). The sectioned grounded conductor shall be enclosed by the sectioned equipment grounding conductor and identified in accordance with 200.6.

(C) Equipment Grounding Conductor (Outer Sectioned Layers).

The equipment grounding conductor shall consist of two overall sectioned conductors that enclose the grounded conductor and ungrounded conductor(s) and shall comply with 250.4(A)(5). The equipment grounding conductor layers shall be identified by any one of the following methods:

(1) As permitted in 250.119

(2) A clear covering

(3) One or more continuous green stripes or hash marks

(4) The term “Equipment ~~Ground~~” Grounding Conductor” printed at regular intervals throughout the cable

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Committee Statement and Meeting Notes

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Response Message:

Public Input No. 3335-NFPA 70-2017 [Section No. 382.104(C)]

Public Input No. 2392-NFPA 70-2017 [Section No. 382.104]

First Revision No. 7700-NFPA 70-2018 [Section No. 382.112]

382.112 Insulation.

The ungrounded and grounded flat conductor layers shall be individually insulated and comply with 310.14(A)(3). The equipment grounding conductor shall be covered or insulated.

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Committee Statement and Meeting Notes

Committee Statement: The revision incorporates terms into this section to clarify what conductors this rule is intended to apply to.

Response Message:

Public Input No. 3336-NFPA 70-2017 [Section No. 382.112]

Public Input No. 2393-NFPA 70-2017 [Section No. 382.112]

Ballot Results

This item has not been balloted

First Revision No. 7701-NFPA 70-2018 [Section No. 394.2]

394.2 Definition.

The definition in this section shall apply within this article and throughout the *Code* .

Concealed Knob-and-Tube Wiring.

A wiring method using knobs, tubes, and flexible nonmetallic tubing for the protection and support of single insulated conductors.

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Committee Statement and Meeting Notes

Committee Statement: Language was added based on the recommendation of the Correlating Committee task group on definitions to improve usability.

Response Message:

Public Input No. 2225-NFPA 70-2017 [Section No. 394.2]

Editorial Comment

Click here

First Revision No. 7702-NFPA 70-2018 [Section No. 396.2]

396.2 Definitions.

Insulated Conductor.

This definition shall apply only within this article.

For the purposes of this article, an insulated conductor includes the following:

(1) Conductor types described in 310.4, and

(2) Overhead service conductors encased in a polymeric material that has been evaluated for the applied nominal voltage.

Informational Note: Evidence of evaluation for the applied nominal voltage can be given by certification that the conductors have met the requirements of ICEA S-76-474-2011, *Standard for Neutral Supported Power Cable Assemblies with Weather-Resistant Extruded Insulation Rated 600 Volts*.

Messenger-Supported Wiring.

This definition shall apply within this article and throughout the *Code* .

An exposed wiring support system using a messenger wire to support insulated conductors by any one of the following:

(1) A messenger with rings and saddles for conductor support

(2) A messenger with a field-installed lashing material for conductor support

(3) Factory-assembled aerial cable

(4) Multiplex cables utilizing a bare conductor, factory assembled and twisted with one or more insulated conductors, such as duplex, triplex, or quadruplex type of construction

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Committee Statement and Meeting Notes

Committee Statement: Language was added based on the recommendation of the Correlating Committee task group on definitions to improve usability.

Response Message:

Public Input No. 2238-NFPA 70-2017 [Section No. 396.2]

Editorial Comment

Click here

First Revision No. 7704-NFPA 70-2018 [Section No. 398.2]

398.2 Definition.

The definition in this section shall apply within this article and throughout the *Code* .

Open Wiring on Insulators.

An exposed wiring method using cleats, knobs, tubes, and flexible tubing for the protection and support of single insulated conductors run in or on buildings.

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Committee Statement and Meeting Notes

Committee Statement: Language was added based on the recommendation of the Correlating Committee task group on definitions to improve usability.

Response Message:

Public Input No. 2226-NFPA 70-2017 [Section No. 398.2]

Editorial Comment

Click here

First Revision No. 7710-NFPA 70-2018 [Section No. 399.2]

399.2 Definition.

The definitions in this section shall apply only within this article.

Outdoor Overhead Conductors.

Single conductors, insulated, covered, or bare, installed outdoors on support structures in free air.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
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Committee Statement and Meeting Notes

Committee Statement: Language was added based on the recommendation of the Correlating Committee task group on definitions to improve usability.

Response Message:

Public Input No. 1212-NFPA 70-2017 [Section No. 399.2]

First Revision No. 7712-NFPA 70-2018 [Section No. 399.30(B)]

(B) Structures.

Structures of wood, metal, or concrete, or combinations of those materials, shall be provided for support of overhead conductors over 1000 volts, nominal. Documentation of the engineered design by a licensed professional engineer engaged primarily in the design of such systems and the installation of each support structure shall be available upon request of the authority having jurisdiction and shall include consideration of the following:

(1) Soil conditions

(2) Foundations and structure settings

(3) Weight of all supported conductors and equipment

(4) Weather loading and other conditions such as, but not limited to, ice, wind, temperature, and lightning

(5) Angle where change of direction occurs

(6) Spans between adjacent structures

(7) Effect of dead-end structures

(8) Strength of ~~guys~~ guy wires and guy anchors

(9) Structure size and material(s)

(10) Hardware

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Committee Statement and Meeting Notes

Committee Statement: In the 2014 edition of the NEC the term "guy" as defined in article 694 was removed because it could be construed as referring to other than guy wires. Replace "guys" with "guy wires."

Response Message:

Public Input No. 2620-NFPA 70-2017 [Section No. 399.30(B)]

Editorial Comment

Click here

First Revision No. 7901-NFPA 70-2018 [Section No. 400.5(A)]

(A) Ampacity Tables.

Table 400.5(A)(a) provides the ~~allowable~~ ampacities, and Table 400.5(A)(b) provides the ampacities for flexible cords and flexible cables with not more than three current-carrying conductors. These tables shall be used in conjunction with applicable end-use product standards to ensure selection of the proper size and type. Where cords and cables are used in ambient temperatures other than 30°C (86°F), the temperature correction factors from Table 310.15(B)(1) that correspond to the temperature rating of the cord or cable shall be applied to the ampacity in Table 400.5(A)(a) and Table 400.5(A)(b). Cords and cables rated 105°C shall use correction factors in the 90°C column of Table 310.15(B)(1) for temperature correction. Where the number of current-carrying conductors exceeds three, the ~~allowable~~ ampacity ~~or the ampacity~~ of each conductor shall be reduced from the three-conductor rating as shown in Table 400.5(A)(c).

Informational Note: See Informative Annex B, Table B.310.15(B)(2)(11), for adjustment factors for more than three current-carrying conductors in a raceway or cable with load diversity.

Table 400.5(A)(a) ~~Allowable~~ Ampacity for Flexible Cords and Flexible Cables

[Based on Ambient Temperature of 30°C (86°F). See 400.13 and Table 400.4.]

Copper Conductor Size (AWG)	-	Thermoset Types C, E, EO, PD, S, SJ, SJO, SJOW, SJOO, SJOOW, SO, SOW, SOO, SOOW, SP-1, SP-2, SP-3, SRD, SV, SVO, SVOO, NISP-1, NISP-2		-
	Thermoplastic Types TPT, TST	Thermoplastic Types ETP, ETT, NISPE-1, NISPE-2, NISPT-1, NISPT-2, SE, SEW, SEO, SEOO, SEOW, SEOOW, SJE, SJEW, SJEO, SJEOO, SJEOW, SJEOOW, SJT, SJTW, SJTO, SJTOW, SJTOO, SJTOOW, SPE-1, SPE-2, SPE-3, SPT-1, SPT-1W, SPT-2, SPT-2W, SPT-3, ST, STW, SRDE, SRDT, STO, STOW, STOO, STOOW, SVE, SVEO, SVEOO, SVT, SVTO, SVTOO		Types HPD, HPN, HSJ, HSJO, HSJOW, HSJOO, HSJOOW
		Column A[~~a~~ 1]	Column B[~~b~~ 2]	
27[~~c~~ 3]	0.5	—	—	—
20	—	5[~~d~~ 4]	[~~e~~ 5]	—
18	—	7	10	10
17	—	9	12	13
16	—	10	13	15
15	—	12	16	17
14	—	15	18	20
13	—	17	21	—
12	—	20	25	30
11	—	23	27	—
10	—	25	30	35
9	—	29	34	—
8	—	35	40	—
7	—	40	47	—
6	—	45	55	—
5	—	52	62	—
4	—	60	70	—
3	—	70	82	—
2	—	80	95	—

[~~a~~ 1] The ~~allowable~~ currents under Column A apply to three-conductor cords and other multiconductor cords connected to utilization equipment so that only three-conductors are current-carrying.

[~~b~~ 2] The ~~allowable~~ currents under Column B apply to two-conductor cords and other multiconductor cords connected to utilization equipment so that only two conductors are current-carrying.

[~~c~~ 3] Tinsel cord.

~~d~~ 4 Elevator cables only.

~~e~~ 5 7 amperes for elevator cables only; 2 amperes for other types.

Table 400.5(A)(b) Ampacity of Cable Types SC, SCE, SCT, PPE, G, G-GC, and W

[Based on Ambient Temperature of 30°C (86°F). See Table 400.4.]

Copper Conductor Size (AWG or kcmil)	Temperature Rating of Cable								
	60°C (140°F)			75°C (167°F)			90°C (194°F)		
	D[1]	E[2]	F[3]	D[1]	E[2]	F[3]	D[1]	E[2]	F[3]
12	—	31	26	—	37	31	—	42	35
10	—	44	37	—	52	43	—	59	49
8	60	55	48	70	65	57	80	74	65
6	80	72	63	95	88	77	105	99	87
4	105	96	84	125	115	101	140	130	114
3	120	113	99	145	135	118	165	152	133
2	140	128	112	170	152	133	190	174	152
1	165	150	131	195	178	156	220	202	177
1/0	195	173	151	230	207	181	260	234	205
2/0	225	199	174	265	238	208	300	271	237
3/0	260	230	201	310	275	241	350	313	274
4/0	300	265	232	360	317	277	405	361	316
250	340	296	259	405	354	310	455	402	352
300	375	330	289	445	395	346	505	449	393
350	420	363	318	505	435	381	570	495	433
400	455	392	343	545	469	410	615	535	468
500	515	448	392	620	537	470	700	613	536
600	575	—	—	690	—	—	780	—	—
700	630	—	—	755	—	—	855	—	—
750	655	—	—	785	—	—	885	—	—
800	680	—	—	815	—	—	920	—	—
900	730	—	—	870	—	—	985	—	—
1000	780	—	—	935	—	—	1055	—	—

[1]The ampacities under subheading D shall be permitted for single-conductor Types SC, SCE, SCT, PPE, and W cable only where the individual conductors are not installed in raceways and are not in physical contact with each other except in lengths not to exceed 600 mm (24 in.) where passing through the wall of an enclosure.

[2]The ampacities under subheading E apply to two-conductor cables and other multiconductor cables connected to utilization equipment so that only two conductors are current-carrying.

[3]The ampacities under subheading F apply to three-conductor cables and other multiconductor cables connected to utilization equipment so that only three conductors are current-carrying.

Table 400.5(A)(c) Adjustment Factors for More Than Three Current-Carrying Conductors in a Flexible Cord or Flexible Cable

Number of Conductors	Percent of Value in Table 400.5(A)(1) and Table 400.5(A)(2)
4–6	80
7–9	70

Number of Conductors	Percent of Value in Table 400.5(A)(1) and Table 400.5(A)(2)
10–20	50
21–30	45
31–40	40
41 and above	35

A neutral conductor that carries only the unbalanced current from other conductors of the same circuit shall not be required to meet the requirements of a current-carrying conductor.

In a 3-wire circuit consisting of two phase conductors and the neutral conductor of a 4-wire, 3-phase, wye-connected system, a common conductor carries approximately the same current as the line-to-neutral currents of the other conductors and shall be considered to be a current-carrying conductor.

On a 4-wire, 3-phase, wye circuit where more than 50 percent of the load consists of nonlinear loads, there are harmonic currents present in the neutral conductor and the neutral conductor shall be considered to be a current-carrying conductor.

An equipment grounding conductor shall not be considered a current-carrying conductor.

Where a single conductor is used for both equipment grounding and to carry unbalanced current from other conductors, as provided for in 250.140 for electric ranges and electric clothes dryers, it shall not be considered as a current-carrying conductor.

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Committee Statement and Meeting Notes

Committee Statement: As per the work of the ampacity task group, the word “allowable” was removed as it is not necessary.

Response Message:

Public Input No. 938-NFPA 70-2017 [Section No. 400.5(A)]

Editorial Comment

Click here

First Revision No. 7931-NFPA 70-2018 [Section No. 400.17]

400.17 Protection from Damage.

Flexible cords and flexible cables shall be protected by bushings or fittings where passing through holes in covers, outlet boxes, or similar enclosures.

In industrial establishments where the conditions of maintenance and supervision ensure that only qualified persons service the installation, flexible cords and flexible cables shall be permitted to be installed in aboveground raceways that are no longer than 15 m (50 ft) to protect the flexible cord or flexible cable from physical damage. Where more than three current-carrying conductors are installed within the raceway, the ~~allowable~~ ampacity shall be ~~reduced~~ adjusted in accordance with Table 400.5(A)(c).

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Committee Statement and Meeting Notes

Committee Statement: The term "allowable" was removed since it was not necessary and the term "reduced" was replaced with the term "adjusted" to correlate with the table title.

Response Message:

Public Input No. 939-NFPA 70-2017 [Section No. 400.17]

First Revision No. 7932-NFPA 70-2018 [Section No. 400.23]

400.23 Equipment Grounding Conductor Identification.

A conductor intended to be used as an equipment grounding conductor shall have a continuous identifying marker readily distinguishing it from the other conductor or conductors. Conductors having a continuous green color or a continuous green color with one or more yellow stripes shall not be used for other than equipment grounding conductors. Cords or cables consisting of integral insulation and a jacket without a nonintegral equipment grounding conductor shall be permitted to be green. The identifying marker shall consist of one of the methods in 400.23(A) or (B).

(A) Colored Braid.

A braid finished to show a continuous green color or a continuous green color with one or more yellow stripes.

(B) Colored Insulation or Covering.

For cords having no braids on the individual conductors, an insulation of a continuous green color or a continuous green color with one or more yellow stripes.

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Committee Statement and Meeting Notes

Committee Statement: The word “equipment” was added in front of the term “grounding conductor” to correspond with the defined term in Article 100.

Response Message:

Public Input No. 2396-NFPA 70-2017 [Section No. 400.23]

Editorial Comment

Click here

First Revision No. 7978-NFPA 70-2018 [Section No. 402.5]

402.5 ~~Allowable~~ Ampacities for Fixture Wires.

The ~~allowable~~ ampacity of fixture wire shall be as specified in Table 402.5.

No conductor shall be used under such conditions that its operating temperature exceeds the temperature specified in Table 402.3 for the type of insulation involved.

Informational Note: See 310.14(A)(3) for temperature limitation of conductors.

Table 402.5 ~~Allowable~~ Ampacity for Fixture Wires

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

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Street Address:
City:
State:
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Committee Statement and Meeting Notes

Committee Statement: Ampacity is the maximum current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating. The term used in this section should be "ampacity" and not "allowable ampacity" as it is the intent for this section to determine the ampacity of the conductor based upon its condition of use.

Response Message:

Public Input No. 940-NFPA 70-2017 [Section No. 402.5]

First Revision No. 7968-NFPA 70-2018 [Annex B]

Informative Annex B Application Information for Ampacity Calculation

This informative annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Equation Application Information.

This informative annex provides application information for ampacities calculated under engineering supervision.

B.2 Typical Applications Covered by Tables.

Typical ampacities for conductors rated 0 through 2000 volts are shown in Table B.310.15(B)(2)(1) through Table B.310.15(B)(2)(10). Table B.310.15(B)(2)(11) provides the adjustment factors for more than three current-carrying conductors in a raceway or cable with load diversity. Underground electrical duct bank configurations, as detailed in Informational Note Figure B.310.15(B)(2)(3), Informational Note Figure B.310.15(B)(2)(4), and Informational Note Figure B.310.15(B)(2)(5), are utilized for conductors rated 0 through 5000 volts. In Figure B.310.15(B)(2)(2) through Informational Note Figure B.310.15(B)(2)(5), where adjacent duct banks are used, a separation of 1.5 m (5 ft) between the centerlines of the closest ducts in each bank or 1.2 m (4 ft) between the extremities of the concrete envelopes is sufficient to prevent derating of the conductors due to mutual heating. These ampacities were calculated as detailed in the basic ampacity paper, AIEE Paper 57-660, *The Calculation of the Temperature Rise and Load Capability of Cable Systems,* by J. H. Neher and M. H. McGrath. For additional information concerning the application of these ampacities, see IEEE STD 835-~~1994~~ , *Standard Power Cable Ampacity Tables*.

Typical values of thermal resistivity (Rho) are as follows:

Average soil (90 percent of USA) = 90

Concrete = 55

Damp soil (coastal areas, high water table) = 60

Paper insulation = 550

Polyethylene (PE) = 450

Polyvinyl chloride (PVC) = 650

Rubber and rubber-like = 500

Very dry soil (rocky or sandy) = 120

Thermal resistivity, as used in this informative annex, refers to the heat transfer capability through a substance by conduction. It is the reciprocal of thermal conductivity and is normally expressed in the units°C-cm/watt. For additional information on determining soil thermal resistivity (Rho), see ~~ANSI/~~ IEEE STD 442-~~1996~~ , *Guide for Soil Thermal Resistivity Measurements*.

B.3 Criteria Modifications.

Where values of load factor and Rho are known for a particular electrical duct bank installation and they are different from those shown in a specific table or figure, the ampacities shown in the table or figure can be modified by the application of factors derived from the use of Figure B.310.15(B)(2)(1).

Where two different ampacities apply to adjacent portions of a circuit, the higher ampacity can be used beyond the point of transition, a distance equal to 3 m (10 ft) or 10 percent of the circuit length calculated at the higher ampacity, whichever is less.

Where the burial depth of direct burial or electrical duct bank circuits are modified from the values shown in a figure or table, ampacities can be modified as shown in (a) and (b) as follows.

(a) Where burial depths are increased in part(s) of an electrical duct run to avoid underground obstructions, no decrease in ampacity of the conductors is needed, provided the total length of parts of the duct run increased in depth to avoid obstructions is less than 25 percent of the total run length.

(b) Where burial depths are deeper than shown in a specific underground ampacity table or figure, an ampacity derating factor of 6 percent per increased 300 mm (foot) of depth for all values of Rho can be utilized. No rating change is needed where the burial depth is decreased.

B.4 Electrical Ducts.

The term *electrical duct(s)* is defined in ~~310.60~~ 311.2 .

B.5 Table B.310.15(B)(2)(6) and Table B.310.15(B)(2)(7).

(a) To obtain the ampacity of cables installed in two electrical ducts in one horizontal row with 190-mm (7.5-in.) center-to-center spacing between electrical ducts, similar to Figure B.310.15(B)(2)(2), Detail 1, multiply the ampacity shown for one duct in Table B.310.15(B)(2)(6) and Table B.310.15(B)(2)(7) by 0.88.

(b) To obtain the ampacity of cables installed in four electrical ducts in one horizontal row with 190-mm (7.5-in.) center-to-center spacing between electrical ducts, similar to Figure B.310.15(B)(2)(2), Detail 2, multiply the ampacity shown for three electrical ducts in Table B.310.15(B)(2)(6) and Table B.310.15(B)(2)(7) by 0.94.

B.6 Electrical Ducts Used in Figure B.310.15(B)(2)(2).

If spacing between electrical ducts, as shown in Figure B.310.15(B)(2)(2), is less than as specified where electrical ducts enter equipment enclosures from underground, the ampacity of conductors contained within such electrical ducts need not be reduced.

B.7 Examples Showing Use of Figure B.310.15(B)(2)(1) for Electrical Duct Bank Ampacity Modifications.

Figure B.310.15(B)(2)(1) is used for interpolation or extrapolation for values of Rho and load factor for cables installed in electrical ducts. The upper family of curves shows the variation in ampacity and Rho at unity load factor in terms of I_1, the ampacity for Rho = 60, and 50 percent load factor. Each curve is designated for a particular ratio I_2/I_1, where I_2 is the ampacity at Rho = 120 and 100 percent load factor.

The lower family of curves shows the relationship between Rho and load factor that will give substantially the same ampacity as the indicated value of Rho at 100 percent load factor.

As an example, to find the ampacity of a 500-kcmil copper cable circuit for six electrical ducts as shown in Table B.310.15(B)(2)(5): At the Rho = 60, LF = 50, I_1 = 583; for Rho = 120 and LF = 100, I_2 = 400. The ratio I_2/I_1 = 0.686. Locate Rho = 90 at the bottom of the chart and follow the 90 Rho line to the intersection with 100 percent load factor where the equivalent Rho = 90. Then follow the 90 Rho line to I_2/I_1 ratio of 0.686 where F = 0.74. The desired ampacity = 0.74 × 583 = 431, which agrees with the table for Rho = 90, LF = 100.

To determine the ampacity for the same circuit where Rho = 80 and LF = 75, using Figure B.310.15(B)(2)(1), the equivalent Rho = 43, F = 0.855, and the desired ampacity = 0.855 × 583 = 498 amperes. Values for using Figure B.310.15(B)(2)(1) are found in the electrical duct bank ampacity tables of this informative annex.

Where the load factor is less than 100 percent and can be verified by measurement or calculation, the ampacity of electrical duct bank installations can be modified as shown. Different values of Rho can be accommodated in the same manner.

Table B.310.15(B)(2)(1) Ampacities of Two or Three Insulated Conductors, Rated 0 Through 2000 Volts, Within an Overall Covering (Multiconductor Cable), in Raceway in Free Air Based on Ambient Air Temperature of 30°C (86°F)*

Size (AWG or kcmil)	Temperature Rating of Conductor. [See Table 310.104(A).]						Size (AWG or kcmil)
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, ZW	Types THHN, THHW, THW-2, THWN-2, RHH, RWH-2, USE-2, XHHW, XHHW-2, ZW-2	Type TW	Types RHW, THHW, THW, THWN, XHHW	Types THHN, THHW, THW-2, THWN-2, RHH, RWH-2,USE-2, XHHW, XHHW-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
14**	16	18	21	—	—	—	14
12**	20	24	27	16	18	21	12
10**	27	33	36	21	25	28	10
8	36	43	48	28	33	37	8
6	48	58	65	38	45	51	6
4	66	79	89	51	61	69	4
3	76	90	102	59	70	79	3
2	88	105	119	69	83	93	2
1	102	121	137	80	95	106	1
1/0	121	145	163	94	113	127	1/0
2/0	138	166	186	108	129	146	2/0
3/0	158	189	214	124	147	167	3/0
4/0	187	223	253	147	176	197	4/0
250	205	245	276	160	192	217	250
300	234	281	317	185	221	250	300
350	255	305	345	202	242	273	350
400	274	328	371	218	261	295	400
500	315	378	427	254	303	342	500

Size (AWG or kcmil)	Temperature Rating of Conductor. [See Table 310.104(A).]						Size (AWG or kcmil)
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, ZW	Types THHN, THHW, THW-2, THWN-2, RHH, RWH-2, USE-2, XHHW, XHHW-2, ZW-2	Type TW	Types RHW, THHW, THW, THWN, XHHW	Types THHN, THHW, THW-2, THWN-2, RHH, RWH-2,USE-2, XHHW, XHHW-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
600	343	413	468	279	335	378	600
700	376	452	514	310	371	420	700
750	387	466	529	321	384	435	750
800	397	479	543	331	397	450	800
900	415	500	570	350	421	477	900
1000	448	542	617	382	460	521	1000

*Refer to 310.15(B)(2) for the ampacity correction factors where the ambient temperature is other than 30°C (86°F).

**Refer to 240.4(D) for conductor overcurrent protection limitations.

Table B.310.15(B)(2)(3) Ampacities of Multiconductor Cables with Not More Than Three Insulated Conductors, Rated 0 Through 2000 Volts, in Free Air Based on Ambient Air Temperature of 40°C (104°F) (for Types TC, MC, MI, UF, and USE Cables)*

- Size (AWG or kcmil)	Temperature Rating of Conductor. [See Table 310.104(A).]								- Size (AWG or kcmil)
	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)	
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
18	—	—	—	11	—	—	—	—	18
16	—	—	—	16	—	—	—	—	16
14**	18	21	24	25	—	—	—	—	14
12**	21	28	30	32	18	21	24	25	12
10**	28	36	41	43	21	28	30	32	10
8	39	50	56	59	30	39	44	46	8
6	52	68	75	79	41	53	59	61	6
4	69	89	100	104	54	70	78	81	4
3	81	104	116	121	63	81	91	95	3
2	92	118	132	138	72	92	103	108	2
1	107	138	154	161	84	108	120	126	1
1/0	124	160	178	186	97	125	139	145	1/0
2/0	143	184	206	215	111	144	160	168	2/0
3/0	165	213	238	249	129	166	185	194	3/0
4/0	190	245	274	287	149	192	214	224	4/0
250	212	274	305	320	166	214	239	250	250
300	237	306	341	357	186	240	268	280	300
350	261	337	377	394	205	265	296	309	350
400	281	363	406	425	222	287	317	334	400

-	Temperature Rating of Conductor. [See Table 310.104(A).]								-
Size (AWG or kcmil)	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)	Size (AWG or kcmil)
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
500	321	416	465	487	255	330	368	385	500
600	354	459	513	538	284	368	410	429	600
700	387	502	562	589	306	405	462	473	700
750	404	523	586	615	328	424	473	495	750
800	415	539	604	633	339	439	490	513	800
900	438	570	639	670	362	469	514	548	900
1000	461	601	674	707	385	499	558	584	1000

*Refer to 310.15(B)(2) for the ampacity correction factors where the ambient temperature is other than 40°C (104°F).

**Refer to 240.4(D) for conductor overcurrent protection limitations.

Table B.310.15(B)(2)(5) Ampacities of Single Insulated Conductors, Rated 0 Through 2000 Volts, in Nonmagnetic Underground Electrical Ducts (One Conductor per Electrical Duct), Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement in Accordance with Figure B.310.15(B)(2)(2), Conductor Temperature 75°C (167°F)

-	3 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 2]			6 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 3]			9 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 4]			3 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 2]			6 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 3]			9 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 4]			-
Size (kcmil)	Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Siz (kcm
	COPPER									ALUMINUM OR COPPER-CLAD ALUMINUM									
	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	
250	410	344	327	386	295	275	369	270	252	320	269	256	302	230	214	288	211	197	250
350	503	418	396	472	355	330	446	322	299	393	327	310	369	277	258	350	252	235	350
500	624	511	484	583	431	400	545	387	360	489	401	379	457	337	313	430	305	284	500
750	794	640	603	736	534	494	674	469	434	626	505	475	581	421	389	538	375	347	750
1000	936	745	700	864	617	570	776	533	493	744	593	557	687	491	453	629	432	399	1000
1250	1055	832	781	970	686	632	854	581	536	848	668	627	779	551	508	703	478	441	1250
1500	1160	907	849	1063	744	685	918	619	571	941	736	689	863	604	556	767	517	477	1500
1750	1250	970	907	1142	793	729	975	651	599	1026	796	745	937	651	598	823	550	507	1750
2000	1332	1027	959	1213	836	768	1030	683	628	1103	850	794	1005	693	636	877	581	535	2000
Ambient Temp. (°C)	Correction Factors																		Ambi Tem (°F)
6–10	1.09			1.09			1.09			1.09			1.09			1.09			43–5

-	3 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 2]	6 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 3]	9 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 4]	3 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 2]	6 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 3]	9 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 4]	-
Size (kcmil)	Types RHW, THHW, THW, THWN, XHHW, USE	Types RHW, THHW, THW, THWN, XHHW, USE	Types RHW, THHW, THW, THWN, XHHW, USE	Types RHW, THHW, THW, THWN, XHHW, USE	Types RHW, THHW, THW, THWN, XHHW, USE	Types RHW, THHW, THW, THWN, XHHW, USE	Siz (kcm
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
11–15	1.04	1.04	1.04	1.04	1.04	1.04	52–5
16–20	1.00	1.00	1.00	1.00	1.00	1.00	61–6
21–25	0.95	0.95	0.95	0.95	0.95	0.95	70–7
26–30	0.90	0.90	0.90	0.90	0.90	0.90	79–8

Table B.310.15(B)(2)(6) Ampacities of Three Insulated Conductors, Rated 0 Through 2000 Volts, Within an Overall Covering (Three-Conductor Cable) in Underground Electrical Ducts (One Cable per Electrical Duct) Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement in Accordance with Figure B.310.15(B)(2)(2), Conductor Temperature 75°C (167°F)

Size (AWG or kcmil)	1 Electrical Duct [Fig. B.310.15(B)(2)(2), Detail 1]			3 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 2]			6 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 3]			1 Electrical Duct [Fig. B.310.15(B)(2)(2), Detail 1]			3 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 2]			6 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 3]		
	Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE		
	COPPER									ALUMINUM OR COPPER-CLAD ALUMINUM								
	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100
8	58	54	53	56	48	46	53	42	39	45	42	41	43	37	36	41	32	30
6	77	71	69	74	63	60	70	54	51	60	55	54	57	49	47	54	42	39
4	101	93	91	96	81	77	91	69	65	78	72	71	75	63	60	71	54	51
2	132	121	118	126	105	100	119	89	83	103	94	92	98	82	78	92	70	65
1	154	140	136	146	121	114	137	102	95	120	109	106	114	94	89	107	79	74
1/0	177	160	156	168	137	130	157	116	107	138	125	122	131	107	101	122	90	84
2/0	203	183	178	192	156	147	179	131	121	158	143	139	150	122	115	140	102	95
3/0	233	210	204	221	178	158	205	148	137	182	164	159	172	139	131	160	116	107
4/0	268	240	232	253	202	190	234	168	155	209	187	182	198	158	149	183	131	121
250	297	265	256	280	222	209	258	184	169	233	207	201	219	174	163	202	144	132
350	363	321	310	340	267	250	312	219	202	285	252	244	267	209	196	245	172	158
500	444	389	375	414	320	299	377	261	240	352	308	297	328	254	237	299	207	190
750	552	478	459	511	388	362	462	314	288	446	386	372	413	314	293	374	254	233
1000	628	539	518	579	435	405	522	351	321	521	447	430	480	361	336	433	291	266

Size (AWG or kcmil)	1 Electrical Duct [Fig. B.310.15(B)(2)(2), Detail 1]	3 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 2]	6 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 3]	1 Electrical Duct [Fig. B.310.15(B)(2)(2), Detail 1]	3 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 2]	6 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 3]
	Types RHW, THHW, THW, THWN, XHHW, USE	Types RHW, THHW, THW, THWN, XHHW, USE	Types RHW, THHW, THW, THWN, XHHW, USE	Types RHW, THHW, THW, THWN, XHHW, USE	Types RHW, THHW, THW, THWN, XHHW, USE	Types RHW, THHW, THW, THWN, XHHW, USE
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM		
AmbientTemp. (°C)	Correction Factors					
6–10	1.09	1.09	1.09	1.09	1.09	1.09
11–15	1.04	1.04	1.04	1.04	1.04	1.04
16–20	1.00	1.00	1.00	1.00	1.00	1.00
21–25	0.95	0.95	0.95	0.95	0.95	0.95
26–30	0.90	0.90	0.90	0.90	0.90	0.90

Table B.310.15(B)(2)(7) Ampacities of Three Single Insulated Conductors, Rated 0 Through 2000 Volts, in Underground Electrical Ducts (Three Conductors per Electrical Duct) Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement in Accordance with Figure B.310.15(B)(2)(2), Conductor Temperature 75°C (167°F)

Size (AWG or kcmil)	1 Electrical Duct [Fig. B.310.15(B)(2)(2), Detail 1]			3 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 2]			6 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 3]			1 Electrical Duct [Fig. B.310.15(B)(2)(2), Detail 1]			3 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 2]			6 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 3]		
	Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE		
	COPPER									ALUMINUM OR COPPER-CLAD ALUMINUM								
	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100	RHO 60 LF 50	RHO 90 LF 100	RHO 120 LF 100
8	63	58	57	61	51	49	57	44	41	49	45	44	47	40	38	45	34	32
6	84	77	75	80	67	63	75	56	53	66	60	58	63	52	49	59	44	41
4	111	100	98	105	86	81	98	73	67	86	78	76	79	67	63	77	57	52
3	129	116	113	122	99	94	113	83	77	101	91	89	83	77	73	84	65	60
2	147	132	128	139	112	106	129	93	86	115	103	100	108	87	82	101	73	67
1	171	153	148	161	128	121	149	106	98	133	119	115	126	100	94	116	83	77
1/0	197	175	169	185	146	137	170	121	111	153	136	132	144	114	107	133	94	87
2/0	226	200	193	212	166	156	194	136	126	176	156	151	165	130	121	151	106	98
3/0	260	228	220	243	189	177	222	154	142	203	178	172	189	147	138	173	121	111
4/0	301	263	253	280	215	201	255	175	161	235	205	198	219	168	157	199	137	126
250	334	290	279	310	236	220	281	192	176	261	227	218	242	185	172	220	150	137

Size (AWG or kcmil)	1 Electrical Duct [Fig. B.310.15(B)(2)(2), Detail 1]			3 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 2]			6 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 3]			1 Electrical Duct [Fig. B.310.15(B)(2)(2), Detail 1]			3 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 2]			6 Electrical Ducts [Fig. B.310.15(B)(2)(2), Detail 3]		
	Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE			Types RHW, THHW, THW, THWN, XHHW, USE		
	COPPER									ALUMINUM OR COPPER-CLAD ALUMINUM								
300	373	321	308	344	260	242	310	210	192	293	252	242	272	204	190	245	165	151
350	409	351	337	377	283	264	340	228	209	321	276	265	296	222	207	266	179	164
400	442	376	361	394	302	280	368	243	223	349	297	284	321	238	220	288	191	174
500	503	427	409	460	341	316	412	273	249	397	338	323	364	270	250	326	216	197
600	552	468	447	511	371	343	457	296	270	446	373	356	408	296	274	365	236	215
700	602	509	486	553	402	371	492	319	291	488	408	389	443	321	297	394	255	232
750	632	529	505	574	417	385	509	330	301	508	425	405	461	334	309	409	265	241
800	654	544	520	597	428	395	527	338	308	530	439	418	481	344	318	427	273	247
900	692	575	549	628	450	415	554	355	323	563	466	444	510	365	337	450	288	261
1000	730	605	576	659	472	435	581	372	338	597	494	471	538	385	355	475	304	276
AmbientTemp. (°C)	**Correction Factors**																	
6–10	1.09			1.09			1.09			1.09			1.09			1.09		
11–15	1.04			1.04			1.04			1.04			1.04			1.04		
16–20	1.00			1.00			1.00			1.00			1.00			1.00		
21–25	0.95			0.95			0.95			0.95			0.95			0.95		
26–30	0.90			0.90			0.90			0.90			0.90			0.90		

Table B.310.15(B)(2)(8) Ampacities of Two or Three Insulated Conductors, Rated 0 Through 2000 Volts, Cabled Within an Overall (Two- or Three-Conductor) Covering, Directly Buried in Earth, Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement in Accordance with Figure B.310.15(B)(2)(2), 100 Percent Load Factor, Thermal Resistance (Rho) of 90

Size (AWG or kcmil)	1 Cable [Fig. B.310.15(B)(2)(2), Detail 5]		2 Cables [Fig. B.310.15(B)(2)(2), Detail 6]		1 Cable [Fig. B.310.15(B)(2)(2), Detail 5]		2 Cables [Fig. B.310.15(B)(2)(2), Detail 6]		Size (AWG or kcmil)
	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	
	TYPES				TYPES				
	UF	RHW, THHW, THW, THWN, XHHW, USE	UF	RHW, THHW, THW, THWN, XHHW, USE	UF	RHW, THHW, THW, THWN, XHHW, USE	UF	RHW, THHW, THW, THWN, XHHW, USE	
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
8	64	75	60	70	51	59	47	55	8

6	85	100	81	95	68	75	60	70	6
4	107	125	100	117	83	97	78	91	4
2	137	161	128	150	107	126	110	117	2
1	155	182	145	170	121	142	113	132	1
1/0	177	208	165	193	138	162	129	151	1/0
2/0	201	236	188	220	157	184	146	171	2/0
3/0	229	269	213	250	179	210	166	195	3/0
4/0	259	304	241	282	203	238	188	220	4/0
250	—	333	—	308	—	261	—	241	250
350	—	401	—	370	—	315	—	290	350
500	—	481	—	442	—	381	—	350	500
750	—	585	—	535	—	473	—	433	750
1000	—	657	—	600	—	545	—	497	1000
Ambient Temp. (°C)	**Correction Factors**								**Ambient Temp. (°F)**
6–10	1.12	1.09	1.12	1.09	1.12	1.09	1.12	1.09	43–50
11–15	1.06	1.04	1.06	1.04	1.06	1.04	1.06	1.04	52–59
16–20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	61–68
21–25	0.94	0.95	0.94	0.95	0.94	0.95	0.94	0.95	70–77
26–30	0.87	0.90	0.87	0.90	0.87	0.90	0.87	0.90	79–86

Note: For ampacities of Type UF cable in underground electrical ducts, multiply the ampacities shown in the table by 0.74.

Table B.310.15(B)(2)(9) Ampacities of Three Triplexed Single Insulated Conductors, Rated 0 Through 2000 Volts, Directly Buried in Earth Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement in Accordance with Figure B.310.15(B)(2)(2), 100 Percent Load Factor, Thermal Resistance (Rho) of 90

Size (AWG or kcmil)	See Fig. B.310.15(B)(2)(2), Detail 7		See Fig. B.310.15(B)(2)(2), Detail 8		See Fig. B.310.15(B)(2)(2), Detail 7		See Fig. B.310.15(B)(2)(2), Detail 8		Size (AWG or kcmil)
	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	
	TYPES				TYPES				
	UF	USE	UF	USE	UF	USE	UF	USE	
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
8	72	84	66	77	55	65	51	60	8
6	91	107	84	99	72	84	66	77	6
4	119	139	109	128	92	108	85	100	4
2	153	179	140	164	119	139	109	128	2
1	173	203	159	186	135	158	124	145	1
1/0	197	231	181	212	154	180	141	165	1/0
2/0	223	262	205	240	175	205	159	187	2/0
3/0	254	298	232	272	199	233	181	212	3/0
4/0	289	339	263	308	226	265	206	241	4/0
250	—	370	—	336	—	289	—	263	250

Size (AWG or kcmil)	See Fig. B.310.15(B)(2)(2), Detail 7		See Fig. B.310.15(B)(2)(2), Detail 8		See Fig. B.310.15(B)(2)(2), Detail 7		See Fig. B.310.15(B)(2)(2), Detail 8		Size (AWG or kcmil)
	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	
	TYPES				TYPES				
	UF	USE	UF	USE	UF	USE	UF	USE	
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
350	—	445	—	403	—	349	—	316	350
500	—	536	—	483	—	424	—	382	500
750	—	654	—	587	—	525	—	471	750
1000	—	744	—	665	—	608	—	544	1000
Ambient Temp.(°C)	**Correction Factors**								**Ambient Temp.(°F)**
6–10	1.12	1.09	1.12	1.09	1.12	1.09	1.12	1.09	43–50
11–15	1.06	1.04	1.06	1.04	1.06	1.04	1.06	1.04	52–59
16–20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	61–68
21–25	0.94	0.95	0.94	0.95	0.94	0.95	0.94	0.95	70–77
26–30	0.87	0.90	0.87	0.90	0.87	0.90	0.87	0.90	79–86

Table B.310.15(B)(2)(10) Ampacities of Three Single Insulated Conductors, Rated 0 Through 2000 Volts, Directly Buried in Earth Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement in Accordance with Figure B.310.15(B)(2)(2), 100 Percent Load Factor, Thermal Resistance (Rho) of 90

Size (AWG or kcmil)	See Fig. B.310.15(B)(2)(2), Detail 9		See Fig. B.310.15(B)(2)(2), Detail 10		See Fig. B.310.15(B)(2)(2), Detail 9		See Fig. B.310.15(B)(2)(2), Detail 10		Size (AWG or kcmil)
	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	
	TYPES				TYPES				
	UF	USE	UF	USE	UF	USE	UF	USE	
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
8	84	98	78	92	66	77	61	72	8
6	107	126	101	118	84	98	78	92	6
4	139	163	130	152	108	127	101	118	4
2	178	209	165	194	139	163	129	151	2
1	201	236	187	219	157	184	146	171	1
1/0	230	270	212	249	179	210	165	194	1/0
2/0	261	306	241	283	204	239	188	220	2/0
3/0	297	348	274	321	232	272	213	250	3/0
4/0	336	394	309	362	262	307	241	283	4/0
250	—	429	—	394	—	335	—	308	250
350	—	516	—	474	—	403	—	370	350
500	—	626	—	572	—	490	—	448	500
750	—	767	—	700	—	605	—	552	750
1000	—	887	—	808	—	706	—	642	1000

Size (AWG or kcmil)	See Fig. B.310.15(B)(2)(2), Detail 9		See Fig. B.310.15(B)(2)(2), Detail 10		See Fig. B.310.15(B)(2)(2), Detail 9		See Fig. B.310.15(B)(2)(2), Detail 10		Size (AWG or kcmil)
	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	
	TYPES				TYPES				
	UF	USE	UF	USE	UF	USE	UF	USE	
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
1250	—	979	—	891	—	787	—	716	1250
1500	—	1063	—	965	—	862	—	783	1500
1750	—	1133	—	1027	—	930	—	843	1750
2000	—	1195	—	1082	—	990	—	897	2000
Ambient Temp.(°C)	**Correction Factors**								**Ambient Temp.(°F)**
6–10	1.12	1.09	1.12	1.09	1.12	1.09	1.12	1.09	43–50
11–15	1.06	1.04	1.06	1.04	1.06	1.04	1.06	1.04	52–59
16–20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	61–68
21–25	0.94	0.95	0.94	0.95	0.94	0.95	0.94	0.95	70–77
26–30	0.87	0.90	0.87	0.90	0.87	0.90	0.87	0.90	79–86

Table B.310.15(B)(2)(11) Adjustment Factors for More Than Three Current-Carrying Conductors in a Raceway or Cable with Load Diversity

Number of Conductors*	Percent of Values in Tables as Adjusted for Ambient Temperature if Necessary
4–6	80
7–9	70
10–24	70**
25–42	60**
43–85	50**

*Number of conductors is the total number of conductors in the raceway or cable adjusted in accordance with 310.15(B)(4) and (5).

**These factors include the effects of a load diversity of 50 percent.

Informational Note: The ampacity limit for 10 through 85 current-carrying conductors is based on the following equation. For more than 85 conductors, special calculations are required that are beyond the scope of this table.

$$A_2 = \left[\sqrt{\frac{0.5N}{E}} \times \left(A_1\right)\right] \text{ or } A_1\text{, whichever is less}$$ **[B.310.15(B)(7)**

where:

A_1 = ampacity from Table 310.16, Table 310.18, Table B.310.15(B)(2)(1), Table B.310.15(B)(2)(6), or Table B.310.15(B)(2)(7) multiplied by the appropriate adjustment factor from Table B.310.15(B)(2)(11).

N = total number of conductors used to select adjustment factor from Table B.310.15(B)(2)(11)

E = number of conductors carrying current simultaneously in the raceway or cable

A_2 = ampacity limit for the current-carrying conductors in the raceway or cable

Example 1

Calculate the ampacity limit for twelve 14 AWG THWN current-carrying conductors (75°C) in a raceway that contains 24 conductors that may, at different times, be current-carrying.

$$A_2 = \sqrt{\frac{(0.5)(24)}{12}} \times 20(0.7)$$

[B.310.15(B)(7

$$= 14 \text{ amperes } (\text{i.e., } 50 \text{ percent diversity})$$

Example 2

Calculate the ampacity limit for eighteen 14 AWG THWN current-carrying conductors (75°C) in a raceway that contains 24 conductors that may, at different times, be current-carrying.

$$A_2 = \sqrt{\frac{(0.5)(24)}{18}} \times 20(0.7) = 11.5 \text{ amperes}$$

[B.310.15(B)(7

Figure B.310.15(B)(2)(1) Interpolation Chart for Cables in a Duct Bank.I_1 = ampacity for Rho = 60, 50 LF; I_2 = ampacity for Rho = 120, 100 LF (load factor); desired ampacity = F × I_1.

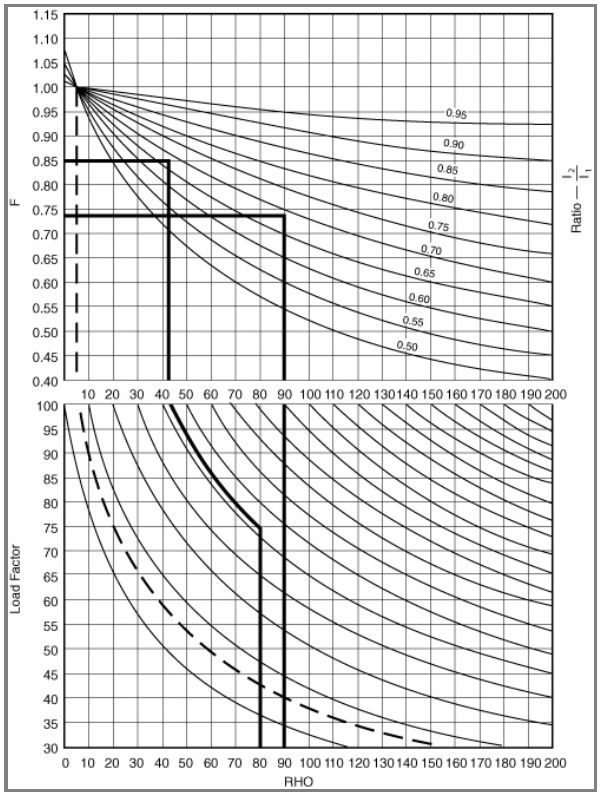


Figure B.310.15(B)(2)(2) Cable Installation Dimensions for Use with Table B.310.15(B)(2)(5) Through Table B.310.15(B)(2)(10).

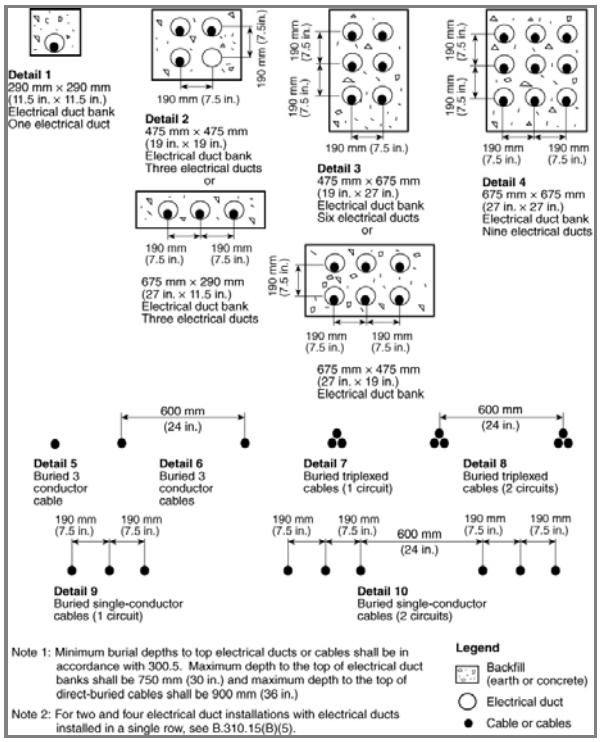
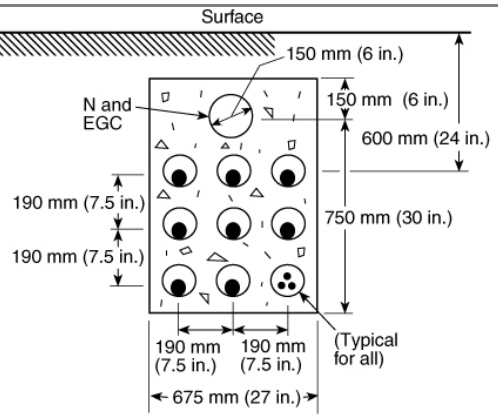


Figure Informational Note Figure B.310.15(B)(2)(3) Ampacities of Single Insulated Conductors Rated 0 Through 5000 Volts in Underground Electrical Ducts (Three Conductors per Electrical Duct), Nine Single-Conductor Cables per Phase Based on Ambient Earth Temperature of 20°C (68°F), Conductor Temperature 75°C (167°F).



Design Criteria
Neutral and Equipment
Grounding conductor (EGC)
Duct = 150 mm (6 in.)
Phase Ducts = 75 to 125 mm (3 to 5 in.)
Conductor Material = Copper
Number of Cables per Duct = 3

Number of Cables per Phase = 9
Rho Concrete = Rho Earth – 5
Rho PVC Duct = 650
Rho Cable Insulation = 500
Rho Cable Jacket = 650

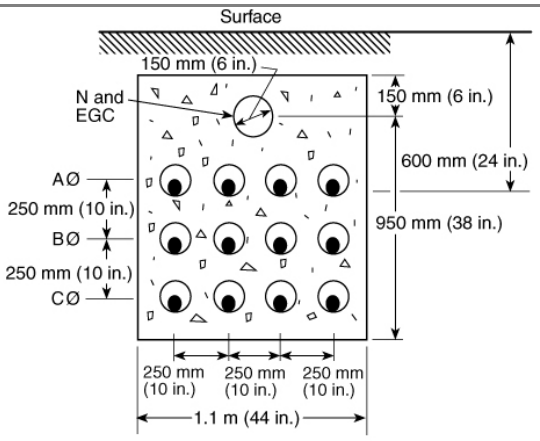
Notes:
1. Neutral configuration per 300.5(I), Exception No. 2, for isolated phase installations in nonmagnetic ducts.
2. Phasing is A, B, C in rows or columns. Where magnetic electrical ducts are used, conductors are installed A, B, C per electrical duct with the neutral and all equipment grounding conductors in the same electrical duct. In this case, the 6-in. trade size neutral duct is eliminated.
3. Maximum harmonic loading on the neutral conductor cannot exceed 50 percent of the phase current for the ampacities shown in the table below.
4. Metallic shields of Type MV-90 cable shall be grounded at one point only where using A, B, C phasing in rows or columns.

Size kcmil	TYPES RHW, THHW, THW, THWN, XHHW, USE, OR MV-90* Total per Phase Ampere Rating			Size kcmil
	RHO EARTH 60 LF 50	RHO EARTH 90 LF 100	RHO EARTH 120 LF 100	
250	2340 (260A/Cable)	1530 (170A/Cable)	1395 (155A/Cable)	250
350	2790 (310A/Cable)	1800 (200A/Cable)	1665 (185A/Cable)	350
500	3375 (375A/Cable)	2160 (240A/Cable)	1980 (220A/Cable)	500

Ambient Temp. (°C)	For ambient temperatures other than 20°C (68°F), multiply the ampacities shown above by the appropriate factor shown below.					Ambient Temp. (°F)
6–10	1.09	1.09	1.09	1.09	1.09	43–50
11–15	1.04	1.04	1.04	1.04	1.04	52–59
16–20	1.00	1.00	1.00	1.00	1.00	61–68
21–25	0.95	0.95	0.95	0.95	0.95	70–77
26–30	0.90	0.90	0.90	0.90	0.90	79–86

*Limited to 75°C conductor temperature.

Figure Informational Note Figure B.310.15(B)(2)(4) Ampacities of Single Insulated Conductors Rated 0 Through 5000 Volts in Nonmagnetic Underground Electrical Ducts (One Conductor per Electrical Duct), Four Single-Conductor Cables per Phase Based on Ambient Earth Temperature of 20°C (68°F), Conductor Temperature 75°C (167°F).



Design Criteria
Neutral and Equipment Grounding conductor (EGC) Duct = 150 mm (6 in.)
Phase Ducts = 75 mm (3 in.)
Conductor Material = Copper
Number of Cables per Duct = 1

Number of Cables per Phase = 4
Rho Concrete = Rho Earth – 5
Rho PVC Duct = 650
Rho Cable Insulation = 500
Rho Cable Jacket = 650

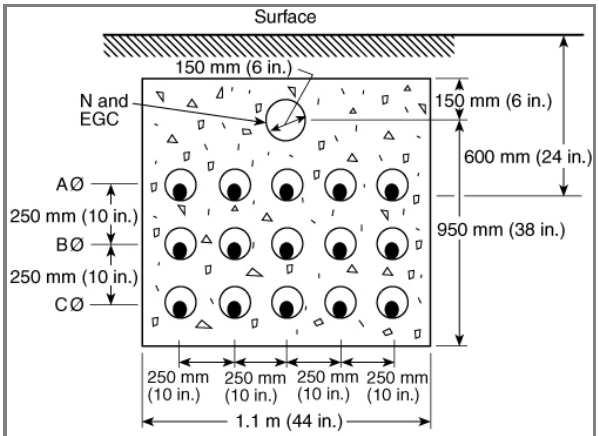
Notes:
1. Neutral configuration per 300.5(I), Exception No 2.
2. Maximum harmonic loading on the neutral conductor cannot exceed 50 percent of the phase current for the ampacities shown in the table below.
3. Metallic shields of Type MV-90 cable shall be grounded at one point only.

Size kcmil	TYPES RHW,THHW,THW,THWN, XHHW,USE,OR MV-90* Total per Phase Ampere Rating			Size kcmil
	RHO EARTH 60 LF 50	RHO EARTH 90 LF 100	RHO EARTH 120 LF 100	
750	2820 (705A/Cable)	1860 (465A/Cable)	1680 (420A/Cable)	750
1000	3300 (825A/Cable)	2140 (535A/Cable)	1920 (480A/Cable)	1000
1250	3700 (925A/Cable)	2380 (595A/Cable)	2120 (530A/Cable)	1250
1500	4060 (1015A/Cable)	2580 (645A/Cable)	2300 (575A/Cable)	1500
1750	4360 (1090A/Cable)	2740 (685A/Cable)	2460 (615A/Cable)	1750

Ambient Temp. (°C)	For ambient temperatures other than 20°C (68°F), multiply the ampacities shown above by the appropriate factor shown below.					Ambient Temp. (°F)
6–10	1.09	1.09	1.09	1.09	1.09	43–50
11–15	1.04	1.04	1.04	1.04	1.04	52–59
16–20	1.00	1.00	1.00	1.00	1.00	61–68
21–25	0.95	0.95	0.95	0.95	0.95	70–77
26–30	0.90	0.90	0.90	0.90	0.90	79–86

*Limited to 75°C conductor temperature.

Figure Informational Note Figure B.310.15(B)(2)(5) Ampacities of Single Insulated Conductors Rated 0 Through 5000 Volts in Nonmagnetic Underground Electrical Ducts (One Conductor per Electrical Duct), Five Single-Conductor Cables per Phase Based on Ambient Earth Temperature of 20°C (68°F), Conductor Temperature 75°C (167°F).



Design Criteria
Neutral and Equipment Grounding conductor (EGC) Duct = 150 mm (6 in.)
Phase Ducts = 75 mm (3 in.)
Conductor Material = Copper
Number of Cables per Duct = 1
Number of Cables per Phase = 5
Rho Concrete = Rho Earth – 5
Rho PVC Duct = 650
Rho Cable Insulation = 500
Rho Cable Jacket = 650

Notes:
1. Neutral configuration per 300.5(I), Exception No. 2.
2. Maximum harmonic loading on the neutral conductor cannot exceed 50 percent of the phase current for the ampacities shown in the table below.
3. Metallic shields of Type MV-90 cable shall be grounded at one point only.

Size kcmil	TYPES RHW, THHW, THW, THWN, XHHW, USE, OR MV-90* Total per Phase Ampere Rating			Size kcmil
	RHO EARTH 60 LF 50	RHO EARTH 90 LF 100	RHO EARTH 120 LF 100	
2000	5575 (1115A/Cable)	3375 (675A/Cable)	3000 (600A/Cable)	2000

Ambient Temp. (°C)	For ambient temperatures other than 20°C (68°F), multiply the ampacities shown above by the appropriate factor shown below.					Ambient Temp. (°F)
6–10	1.09	1.09	1.09	1.09	1.09	43–50
11–15	1.04	1.04	1.04	1.04	1.04	52–59
16–20	1.00	1.00	1.00	1.00	1.00	61–68
21–25	0.95	0.95	0.95	0.95	0.95	70–77
26–30	0.90	0.90	0.90	0.90	0.90	79–86

*Limited to 75°C conductor temperature.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jan 11 13:47:22 EST 2018

Committee Statement and Meeting Notes

Committee Statement: The dates were removed to reflect current editions. The reference in B.4 was updated to reflect the new Article 311.
Response Message:

Public Input No. 365-NFPA 70-2017 [Annex B]

Editorial Comment

Click here

First Revision No. 7861-NFPA 70-2018 [New Part after I.]

Free Air (as applied to conductors).

Open or ventilated environment that allows for air flow around an installed conductor with no other conductors closer than one cable diameter and no insulation or building materials in contact with the conductor insulation for more than 75 mm (3 in.) for every 3 m (10 ft) of conductor.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 16:29:40 EST 2018

Committee Statement and Meeting Notes

Committee Statement: The term "free air" is used for many wiring methods in the code, but there is no definition to help determine if a wiring method should be considered to be installed in free air. This definition would make it clear that contact or close proximity with additional conductors or other materials that could impede the flow of heat away from the conductor would not allow the use of free air ampacity ratings. (CMP6)

Response Message:

Committee Notes:

Date	Submitted By	
Jan 18, 2018	NEC-CMP Panel 06	Place new def alphabetically

Public Input No. 3621-NFPA 70-2017 [New Part after I.]

Editorial Comment

Click here

First Revision No. 7959-NFPA 70-2018 [Section No. 320.80(A)]

(A) Thermal Insulation.

Armored cable installed in thermal insulation shall have conductors rated at 90°C (194°F). The ampacity of cable installed in these applications shall not exceed that of a 60°C (140°F) rated conductor. The 90°C (194°F) rating shall be permitted to be used for ampacity adjustment and correction calculations; however, the ampacity shall not exceed that of a 60°C (140°F) rated conductor.

Where more than two Type AC cables containing two or more current-carrying conductors in each cable are installed in contact with thermal insulation, caulk, or sealing foam without maintaining spacing between cables, the ampacity of each conductor shall be adjusted in accordance with Table 310.15(C)(1).

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jan 11 13:09:55 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Information was submitted in support of public input 4287 demonstrating that multiple cables in contact with thermal insulation create the potential for heating beyond the capabilities of the cables. This language will require spacing between the cables or derating of the conductor ampacity.

Response Message:

Editorial Comment

Click here

First Revision No. 7961-NFPA 70-2018 [Section No. 330.80]

330.80 Ampacity.

The ampacity of Type MC cable shall be determined in accordance with 310.14 or 311.60 for 14 AWG and larger conductors and in accordance with Table 402.5 for 18 AWG and 16 AWG conductors. The installation shall not exceed the temperature ratings of terminations and equipment.

(A) Type MC Cable Installed in Cable Tray.

The ampacities for Type MC cable installed in cable tray shall be determined in accordance with 392.80.

(B) Single Type MC Conductors Grouped Together.

Where single Type MC conductors are grouped together in a triangular or square configuration and installed on a messenger or exposed with a maintained free airspace of not less than 2.15 times one conductor diameter (2.15 × O.D.) of the largest conductor contained within the configuration and adjacent conductor configurations or cables, the ampacity of the conductors shall not exceed the allowable ampacities in the following tables:

(1) Table 310.20 for conductors rated 0 volts through 2000 volts

(2) Table 310.60(C)(67) and Table 310.60(C)(68) for conductors rated over 2000 volts

(C) Thermal Insulation.

Where more than two Type MC cables containing two or more current-carrying conductors in each cable are installed in contact with thermal insulation, caulk, or sealing foam without maintaining spacing between cables, the ampacity of each conductor shall be adjusted in accordance with Table 310.15(C)(1).

Submitter Information Verification

Submitter Full Name:
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jan 11 13:13:38 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Information was submitted in support of public input 4287 demonstrating that multiple cables in contact with thermal insulation create the potential for heating beyond the capabilities of the cables. This language will require spacing between the cables or derating of the conductor ampacity.

Response Message:

Editorial Comment

Click here

First Revision No. 7883-NFPA 70-2018 [New Section after 330.116]

330.130

Where used in Class I, Division 1 or Zone 1 locations, the cable shall be listed and marked MC-HL and shall have a gas/vapor tight continuous corrugated metallic sheath, an overall jacket of suitable polymeric material, and a separate equipment grounding conductor.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 17:19:53 EST 2018

Committee Statement and Meeting Notes

Committee Statement: These are cable construction requirements that belong in Article 330. This code-making panel has purview over construction requirements for MC cable.

Response Message:

Public Input No. 3961-NFPA 70-2017 [Section No. 330.10(A)]

Editorial Comment

Click here

First Revision No. 8002-NFPA 70-2018 [Section No. 334.2]

334.2 Definitions.

The definitions in this section shall apply within this article and throughout the *Code* .

Nonmetallic-Sheathed Cable.

A factory assembly of two or more insulated conductors enclosed within an overall nonmetallic jacket.

Type NM.

Insulated conductors enclosed within an overall nonmetallic jacket.

Type NMC.

Insulated conductors enclosed within an overall, corrosion resistant, nonmetallic jacket.

~~**Type NMS.**~~

~~Insulated power or control conductors with signaling, data, and communications conductors within an overall nonmetallic jacket.~~

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jan 11 16:42:34 EST 2018

Committee Statement and Meeting Notes

Committee Statement: This added language provides clarity for the application of the definitions in article 334.

Type NMS cable construction is not manufactured.

Response Message:

Public Input No. 3948-NFPA 70-2017 [Definition: Type NMS.]

Public Input No. 2188-NFPA 70-2017 [Section No. 334.2]

Editorial Comment

Click here

First Revision No. 8020-NFPA 70-2018 [Section No. 334.10]

334.10 Uses Permitted.

Type NM~~,~~ and Type NMC~~, and Type NMS~~ cables shall be permitted to be used in the following, except as prohibited in 334.12:

(1) One- and two-family dwellings and their attached or detached garages, and their storage buildings.

(2) Multi-family dwellings permitted to be of Types III, IV, and V construction.

(3) Other structures permitted to be of Types III, IV, and V construction. Cables shall be concealed within walls, floors, or ceilings that provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of fire-rated assemblies.

Informational Note No. 1: Types of building construction and occupancy classifications are defined in NFPA 220-~~2015~~ 2018 , *Standard on Types of Building Construction*, or the applicable building code, or both.

Informational Note No. 2: See Informative Annex E for determination of building types. [NFPA 220, Table ~~3-1~~ 4.1.1]

(4) Cable trays in structures permitted to be Types III, IV, or V where the cables are identified for the use.

Informational Note: See 310.14(A)(3) for temperature limitation of conductors.

(5) Types I and II construction where installed within raceways permitted to be installed in Types I and II construction.

(A) Type NM.

Type NM cable shall be permitted as follows:

(1) For both exposed and concealed work in normally dry locations except as prohibited in 334.10(3)

(2) To be installed or fished in air voids in masonry block or tile walls

(B) Type NMC.

Type NMC cable shall be permitted as follows:

(1) For both exposed and concealed work in dry, moist, damp, or corrosive locations, except as prohibited by 334.10(3)

(2) In outside and inside walls of masonry block or tile

(3) In a shallow chase in masonry, concrete, or adobe protected against nails or screws by a steel plate at least 1.59 mm (1⁄16 in.) thick and covered with plaster, adobe, or similar finish

~~**(C)** Type NMS.~~

~~Type NMS cable shall be permitted as follows:~~

~~(0) For both exposed and concealed work in normally dry locations except as prohibited by 334.10(3)~~

~~(0) To be installed or fished in air voids in masonry block or tile walls~~

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:

Submittal Date: Thu Jan 11 17:35:51 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Type NMS cable construction is not manufactured.

Response Message:

Committee Notes:

Date	Submitted By	
Jan 11, 2018	NEC-CMP Panel 06	The informational notes are not new, remove underlining.

Public Input No. 4002-NFPA 70-2017 [Section No. 334.10(C)]

Editorial Comment

Click here

First Revision No. 7635-NFPA 70-2018 [Section No. 336.2]

336.2 Definition.

The definition in this section shall apply within this article and throughout this *Code* .

Power and Control Tray Cable, Type TC.

A factory assembly of two or more insulated conductors, with or without associated bare or covered equipment grounding conductors, under a nonmetallic jacket.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jan 09 10:41:57 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Language was added based on the recommendation of the Correlating Committee task group on definitions to improve usability. The term equipment was added to clarify which grounding conductors are referenced.

Response Message:

Public Input No. 3333-NFPA 70-2017 [Definition: Power and Control Tray Cable, Type TC.]

Public Input No. 3328-NFPA 70-2017 [Section No. 336.2]

Public Input No. 2189-NFPA 70-2017 [Section No. 336.2]

Editorial Comment

Click here

First Revision No. 8032-NFPA 70-2018 [Section No. 336.10]

336.10 Uses Permitted.

Type TC cable shall be permitted to be used as follows:

(1) For power, lighting, control, and signal circuits.

(2) In cable trays, including those with mechanically discontinuous segments up to 300 mm (1 ft).

(3) In raceways.

(4) In outdoor locations supported by a messenger wire.

(5) For Class 1 circuits as permitted in Parts II and III of Article 725.

(6) For non–power-limited fire alarm circuits if conductors comply with the requirements of 760.49.

(7) Between a cable tray and the utilization equipment or device(s), provided all of the following apply:

a. The cable is Type TC-ER.

b. The cable is installed in industrial establishments where the conditions of maintenance and supervision ensure that only qualified persons service the installation.

c. The cable is continuously supported and protected against physical damage using mechanical protection such as struts, angles, or channels.

d. The cable ~~that~~ complies with the crush and impact requirements of Type MC cable and is identified with the marking “TC–ER.”

e. The cable is secured at intervals not exceeding 1.8 m (6 ft).

f. Equipment grounding for the utilization equipment is provided by an equipment grounding conductor within the cable. In cables containing conductors sized 6 AWG or smaller, the equipment grounding conductor must be provided within the cable or, at the time of installation, one or more insulated conductors must be permanently identified as an equipment grounding conductor in accordance with 250.119(B).

Exception to (7): Where not subject to physical damage, Type TC-ER shall be permitted to transition between cable trays and between cable trays and utilization equipment or devices for a distance not to exceed 1.8 m (6 ft) without continuous support. The cable shall be mechanically supported where exiting the cable tray to ensure that the minimum bending radius is not exceeded.

(8) Where installed in wet locations, Type TC cable shall also be resistant to moisture and corrosive agents.

(9) In one- and two-family dwelling units, Type TC-ER cable containing both power and control conductors that is identified for pulling through structural members shall be permitted for branch circuits and feeders . Type TC-ER cable used as interior wiring shall be installed per the requirements of Part II of Article 334 and where installed as exterior wiring shall be installed per the requirements of Part II of Article 340 .

Exception: Where used to connect a generator and associated equipment having terminals rated 75°C (140°F) or higher, the cable shall not be limited in ampacity by 334.80 or 340.80.

Informational Note No. 1: TC-ER cable that is suitable for pulling through structural members is marked “JP.”

Informational Note No. 2: See 725.136 for limitations on Class 2 or 3 circuits contained within the same cable with conductors of electric light, power, or Class 1 circuits.

(10) Direct buried, where identified for such use.

(11) In hazardous (classified) locations where specifically permitted by other articles in this *Code* .

Informational Note: See 310.14(A)(3) for temperature limitation of conductors.

Submitter Information Verification

Submitter Full Name:
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Fri Jan 12 00:03:45 EST 2018

Committee Statement and Meeting Notes

Committee Statement: The determination of an industrial establishment is up to the AHJ. The words “for branch circuits and feeders” were added to indicate that Type TC-ER-JP is not allowed for use as a service. The reference to Part II of Article 340 was added to direct the user to installation requirements for TC-ER-JP used as exterior wiring. List item 11 was added in response to PI 4258.

Response Message:

Committee Notes:

Date	Submitted By	
Jan 12, 2018	NEC-CMP Panel 06	Items underlined in (7) are not new remove underlining.

Public Input No. 2846-NFPA 70-2017 [Section No. 336.10]

Public Input No. 4036-NFPA 70-2017 [Section No. 336.10]

Editorial Comment

Click here

First Revision No. 7647-NFPA 70-2018 [New Section after 336.120]

336.130 Hazardous (Classified) Location Cable.

Cable listed and marked Type TC-ER-HL shall comply with the following:

(1) The overall nonmetallic jacket shall be suitable for the environment.

(2) The overall cable construction shall be essentially circular in cross-section.

(3) The overal nonmetallic jacket shall be continuous and gas/vapor tight.

(4) For construction greater than 25.4 mm (1 in.) in diameter, the following shall apply:

a. The equipment grounding conductor shall be bare.

b. A metalic shield shall be included over all conductors under the outter jacket.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jan 09 11:26:48 EST 2018

Committee Statement and Meeting Notes

Committee Statement: This language addresses construction requirements for tray cables installed in hazardous locations, including suitability for the environment and compatibility with connectors. The inclusion of the shield allows for testing of the cable to ensure jacket continuity and a ground fault path within the cable. See Chapter 5 for applications and limitations.

Response Message:

Public Input No. 4258-NFPA 70-2017 [Section No. 336.10]

Editorial Comment

Click here

First Revision No. 7953-NFPA 70-2018 [Section No. 338.2]

338.2 Definitions.

The definition in this section shall apply within this article and throughout the *Code* .

Service-Entrance Cable.

A single conductor or multiconductor ~~assembly~~ cable provided with ~~or without~~ an overall covering, primarily used for services, and of the following types:

Type SE.

Service-entrance cable having a flame-retardant, moisture-resistant covering.

Type USE.

Service-entrance cable, identified for underground use, having a moisture-resistant covering, but not required to have a flame-retardant covering.

Service-Entrance Conductor Assemby.

Multiple single-insulated conductors twisted together without an overall covering, other than an optional binder intended only to keep the conductors together.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jan 11 12:56:05 EST 2018

Committee Statement and Meeting Notes

Committee Statement: The language recommended by the CC Task Group on definitions was added and a new definition was added to clarify the difference between an assembly and a cable. The words “or without” were removed from the definition of service-entrance cable since that construction is now included in the service-entrance conductor assembly definition.

Response Message:

Public Input No. 3787-NFPA 70-2017 [New Definition after Definition: Service-Entrance Cable.]

Public Input No. 2190-NFPA 70-2017 [Section No. 338.2]

Editorial Comment

Click here

First Revision No. 7955-NFPA 70-2018 [Section No. 338.10(B)(4)]

(4) Installation Methods for Branch Circuits and Feeders.

Informational Note No. 1: See ~~310.14(A)(3)~~ 310.15 for temperature limitation of conductors.

Informational Note No. 2: For the installation of main power feeder conductors in dwelling units refer to 310.12.

(a) *Interior Installations.*

(1) In addition to the provisions of this article, Type SE service-entrance cable used for interior wiring shall comply with the installation requirements of Part II of Article 334, excluding 334.80.

(2) Where more than two Type SE cables containing two or more current-carrying conductors in each cable are installed in contact with thermal insulations, caulk, or sealing foam without maintaining spacing between cables, the ampacity of each conductor shall be adjusted in accordance with Table 310.15(C)(1).

(3) For Type SE cable with ungrounded conductor sizes 10 AWG and smaller, where installed in contact with thermal insulation, the ampacity shall be in accordance with 60°C (140°F) conductor temperature rating. The maximum conductor temperature rating shall be permitted to be used for ampacity adjustment and correction purposes, if the final ~~derated~~ ampacity does not exceed that for a 60°C (140°F) rated conductor.

(b) *Exterior Installations.*

(1) In addition to the provisions of this article, service-entrance cable used for feeders or branch circuits, where installed as exterior wiring, shall be installed in accordance with Part I of Article 225. The cable shall be supported in accordance with 334.30.

(2) Type USE cable installed as underground feeder and branch circuit cable shall comply with Part II of Article 340.

Exception: Single-conductor Type USE and multi-rated USE conductors shall not be subject to the ampacity limitations of Part II of Article 340.

Supplemental Information

File Name	Description	Approved
Revised_Section_338.10-B-4.docx	Revise section 338.10(B)(4) per attached word doc. For staff use	✓

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jan 11 13:02:11 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Information was submitted demonstrating that multiple cables in contact with thermal insulation create the potential for heating beyond the capabilities of the cables. This language will require spacing between the cables or ampacity adjustment. “Derated” was deleted based on the work of the CC Task

Group on ampacity.

Response Message:

Public Input No. 4287-NFPA 70-2017 [Section No. 338.10(B)(4)]

Public Input No. 925-NFPA 70-2017 [Section No. 338.10(B)(4)]

Editorial Comment

Click here

First Revision No. 7777-NFPA 70-2018 [Section No. 340.10]

340.10 Uses Permitted.

Type UF cable shall be permitted as follows:

(1) For use underground, including direct burial in the earth. ~~For underground requirements, see 300.5 .~~

(2) As single-conductor cables. Where installed as single-conductor cables, all conductors of the feeder ~~grounded conductor~~ or branch circuit, including the grounded conductor and equipment grounding conductor, if any, shall be installed in accordance with 300.3.

(3) For wiring in wet, dry, or corrosive locations ~~under the recognized wiring methods of this *Code* .~~

(4) Installed as nonmetallic-sheathed cable. Where so installed, the installation and conductor requirements shall comply with Parts II and III of Article 334 and shall be of the multiconductor type.

(4) ~~For solar photovoltaic systems in accordance with 690.31 .~~

(5) As single-conductor cables as the nonheating leads for heating cables as provided in 424.43.

(6) Supported by cable trays. Type UF cable supported by cable trays shall be of the multiconductor type.

Informational Note: See 310.14(A)(3) for temperature limitation of conductors.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 09:28:39 EST 2018

Committee Statement and Meeting Notes

Committee Statement: The reference to 300.5 in list item 1 was unnecessary and therefore deleted. The words “grounded conductors” were incorrect and were therefore deleted. The phrase in list item 3 was deleted since it was unnecessary. List item 5 was deleted, as solar PV wiring methods are covered in Article 690. Renumbered list accordingly.

Response Message:

Committee Notes:

Date	Submitted By	
Jan 10, 2018	NEC-CMP Panel 06	The informational note after list item (8) is not new.

Public Input No. 3367-NFPA 70-2017 [Section No. 340.10]

Public Input No. 3082-NFPA 70-2017 [Section No. 340.10]

Public Input No. 1123-NFPA 70-2017 [Section No. 340.10]

Public Input No. 4263-NFPA 70-2017 [Section No. 340.10]

Public Input No. 3084-NFPA 70-2017 [Section No. 340.10]

First Revision No. 7776-NFPA 70-2018 [Section No. 340.12]

340.12 Uses Not Permitted.

Type UF cable shall not be used as follows:

(1) As service-entrance cable

(2) In commercial garages

(3) In theaters and similar locations

(4) In motion picture studios

(5) In storage battery rooms

(6) In hoistways or on elevators or escalators

(7) In hazardous (classified) locations, except as specifically permitted by other articles in this *Code*

(8) Embedded in poured cement, concrete, or aggregate, except where embedded in plaster as nonheating leads where permitted in 424.43

(9) Where exposed to direct rays of the sun, unless identified as sunlight resistant

Informational Note: The sunlight-resistant marking on the jacket does not apply to the individual conductors.

(10) Where subject to physical damage

(11) As overhead cable, except where installed as messenger-supported wiring in accordance with Part II of Article 396

Supplemental Information

File Name	Description	Approved
PI_4303_Revised.docx	Added informational note to list item (9). For staff use	✓

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jan 10 09:22:41 EST 2018

Committee Statement and Meeting Notes

Committee Statement: The informational note lets the code user know that a sunlight resistant cable may not have sunlight resistant inner conductors.

Response Message:

Public Input No. 4303-NFPA 70-2017 [Section No. 340.112]

Editorial Comment

Click here

First Revision No. 7711-NFPA 70-2018 [Section No. 399.10]

399.10 Uses Permitted.

Outdoor overhead conductors over 1000 volts, nominal, shall be permitted only for systems rated over 1000 volts, nominal, as follows:

(1) Outdoors in free air

(2) For service conductors, feeders, or branch circuits

Informational Note: For additional information on outdoor overhead conductors over 1000 volts, see IEEE C2~~-2012~~ , *National Electrical Safety Code*, and ANSI/IEEE 3001.2, *Recommended Practice for Evaluating the Electrical Service Requirements of Industrial and Commercial Power Systems*.

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jan 09 16:50:39 EST 2018

Committee Statement and Meeting Notes

Committee Statement: The date was removed from the informational note to acknowledge that the latest version should be applied.

Response Message:

Public Input No. 828-NFPA 70-2017 [Section No. 399.10]

First Revision No. 7911-NFPA 70-2018 [Section No. 400.1]

400.1 Scope.

This article covers general requirements, applications, and construction specifications for flexible cords and flexible cables.

~~Informational Note: UL 817, *Cord Sets and Power-Supply Cords* , allows the use of flexible cords manufactured in accordance with UL 62, *Flexible Cords and Cables* . See 400.10 and 400.12 for flexible cords that are part of a listed cord set or power-supply cord.~~

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jan 11 09:48:26 EST 2018

Committee Statement and Meeting Notes

Committee Statement: tThe Informational note is appropriately located under 400.12 and was revised for clarity.
Response Message:

First Revision No. 7917-NFPA 70-2018 [Section No. 400.4]

400.4 Types.

Flexible cords and flexible cables shall conform to the description in Table 400.4. The use of flexible cords and flexible cables other than those in Table 400.4 shall require permission by the authority having jurisdiction.

Table 400.4 Flexible Cords and Flexible Cables

Trade Name	Type Letter	Voltage	AWG or kcmil	Number of Conductors	Insulation	AWG or kcmil	Nominal Insulation Thickness mm	Nominal Insulation Thickness mils	Braid on Each Conductor	Co
Lamp cord	C	300 600	18–16 15–10	2 or more	Thermoset or thermoplastic	18–16 15–10	0.76 1.14	30 45	Cotton	None
Elevator cable	E [1,2,3,4]	300 or 600	20–2	2 or more	Thermoset	20–16 15–12 12–10 8–2	0.51 0.76 1.14 1.52	20 30 45 60	Cotton	Three outer flame retar mois resis
						20–16 15–12 12–10 8–2	0.51 0.76 1.14 1.52	20 30 45 60	Flexible nylon jacket	
Elevator cable	EO [1,2,4]	300 or 600	20–2	2 or more	Thermoset	20–16 15–12 12–10 8–2	0.51 0.76 1.14 1.52	20 30 45 60	Cotton	Three outer flame retar mois resis
										One and neop jacke
Elevator cable	ETP [2,4]	300 or 600							Rayon	Ther plast
	ETT [2,4]	300 or 600							None	One equi and plast jacke
Electric vehicle cable	EV [5,6]	~~600~~ 1000	18–500	2 or more plus equipment grounding conductor(s), plus optional hybrid data, signal communica-	Thermoset with optional nylon	18–15	0.76 (0.51)	30 (20)	Optional	Oil-r therr
						14–10	1.14 (0.76)	45 (30)		
						8–2	1.52 (1.14)	60 (45)		

Trade Name	Type Letter	Voltage	AWG or kcmil	Number of Conductors	Insulation	AWG or kcmil	Nominal Insulation Thickness mm	Nominal Insulation Thickness mils	Braid on Each Conductor	Co
						1–4/0	2.03 (1.52)	80 (60)		
				tions, and optical fiber cables		250–500	2.41 (1.90)	95 (75)		
	EVJ [5,6]	300	18–12			18–12	0.76 (0.51)	30 (20)		
	EVE [5,6]	~~600~~ 1000	18–500	2 or more plus equipment grounding conductor(s), plus optional hybrid data, signal communica- tions, and optical fiber cables	Thermoplastic elastomer with optional nylon	18–15	0.76 (0.51)	30 (20)		Oil-r therr plast elast
						14–10	1.14 (0.76)	45 (30)		
						8–2	1.52 (1.14)	60 (45)		
						1–4/0	2.03 (1.52)	80 (60)		
						250– 500	2.41 (1.90)	95 (75)		
	EVJE [5,6]	300	18–12			18–12	0.76 (0.51)	30 (20)		
	EVT [5,6]	~~600~~ 1000	18–500	2 or more plus equipment grounding conductor(s), plus optional hybrid data, signal communica- tions, and optical fiber cables	Thermoplastic with optional nylon	18–15	0.76 (0.51)	30 (20)	Optional	Oil-r therr plast
						14–10	1.14 (0.76)	45 (30)		
						8–2	1.52 (1.14)	60 (45)		
						1–4/0	2.03 (1.52)	80 (60)		
						250– 500	2.41 (1.90)	95 (75)		
	EVJT [5,6]	300	18–12			18–12	0.76 (0.51)	30 (20)		
Portable power cable	G	2000	12–500	2–6 plus equipment grounding conductor(s)	Thermoset	12–2 1–4/0 250–500	1.52 2.03 2.41	60 80 95		Oil-r therr
	G-GC[7]	2000	12–500	3–6 plus equipment grounding conductors and 1 ground check	Thermoset	12–2 1–4/0 250–500	1.52 2.03 2.41	60 80 95		Oil-r therr

Trade Name	Type Letter	Voltage	AWG or kcmil	Number of Conductors	Insulation	AWG or kcmil	Nominal Insulation Thickness		Braid on Each Conduc-tor	Co
							mm	mils		
				conductor						
Heater cord	HPD	300	18–12	2, 3, or 4	Thermoset	18–16 15–12	0.38 0.76	15 30	None	Cott rayo
Parallel heater cord	HPN[8]	300	18–12	2 or 3	Oil-resistant thermoset	18–16 15 14 12	1.14 1.52 2.41	45 60 95	None	Oil-r therr
Thermoset jacketed heater cords	HSJ	300	18–12	2, 3, or 4	Thermoset	18–16 15–12	0.76 1.14	30 45	None	Cott therr
	HSJW	300	18–12		Thermoset					Cott therr
	HSJO	300	18–12		Oil-resistant thermoset					Cott oil-re therr
	HSJOW[9]	300	18–12							
	HSJOO	300	18–12							
	HSJOOW [9]	300	18–12							
Non-integral parallel cords	NISP-1	300	20–18	2 or 3	Thermoset	20–18	0.38	15	None	Ther
	NISP-2	300	18–16			18–16	0.76	30		
	NISPE-1[8]	300	20–18		Thermoplastic elastomer	20–18	0.38	15		Ther plast elast
	NISPE-2[8]	300	18–16			18–16	0.76	30		
	NISPT-1[8]	300	20–18		Thermoplastic	20–18	0.38	15		Ther plast
	NISPT-2[8]	300	18–16			18–16	0.76	30		
Twisted portable cord	PD	300 600	18–16 14–10	2 or more	Thermoset or thermoplastic	18–16 15–10	0.76 1.14	30 45	Cotton	Cott rayo
Portable power cable	PPE[7]	2000	12–500	1–6 plus optional equipment grounding conductor(s)	Thermoplastic elastomer	12–2 1–4/0 250–500	1.52 2.03 2.41	60 80 95		Oil-r therr plast elast
Hard service cord	S[7]	600	18–2	2 or more	Thermoset	18–15 14–10 8–2	0.76 1.14 1.52	30 45 60	None	Ther

Trade Name	Type Letter	Voltage	AWG or kcmil	Number of Conductors	Insulation	AWG or kcmil	Nominal Insulation Thickness		Braid on Each Conduc-tor	Co
							mm	mils		
Flexible stage and lighting power cable	SC[7,10]	600	8–250	1 or more	Thermoset	8–2 1–4/0 250	1.52 2.03 2.41	60 80 95		Ther
	SCE[7,10]	600			Thermoplastic elastomer					Ther plast elast
	SCT[7,10]	600			Thermoplastic					Ther plast
Hard service cord	SE[7]	600	18–2	2 or more	Thermoplastic elastomer	18–15 14–9 8–2	0.76 1.14 1.52	30 45 60	None	Ther plast elast
	SEW[7, 9]	600								
	SEO[7]	600								Oil-resis therm plast elast
	SEOW[7,9]	600								
	SEOO[7]	600			Oil-resistant thermoplastic elastomer					
	SEOOW[7,9]	600								
Junior hard service cord	SJ	300	18–10	2–6	Thermoset	18–11 10	0.76 1.14	30 45	None	Ther
	SJE	300			Thermoplastic elastomer					Ther plast elast
	SJEW[9]	300								
	SJEO	300								Oil-resis therm plast elast

Trade Name	Type Letter	Voltage	AWG or kcmil	Number of Conductors	Insulation	AWG or kcmil	Nominal Insulation Thickness		Braid on Each Conductor	Co
							mm	mils		
	SJEOW[9]	300								
	SJEOO	300			Oil-resistant thermoplastic elastomer					
	SJEOOW[9]	300								
	SJO	300			Thermoset					Oil-resis therm
	SJOW[9]	300								
	SJOO	300			Oil-resistant thermoset					
	SJOOW[9]	300								
	SJT	300			Thermoplastic					Ther plast
	SJTW[9]	300								
	SJTO	300				18–12 10	0.76 1.14	30 45		Oil-r therm lastic
	SJTOW[9]	300								
	SJTOO	300			Oil-resistant thermoplastic					
	SJTOOW[9]	300								
Hard service cord	SO[7]	600	18–2	2 or more	Thermoset	18–15	0.76	30	None	Oil-r therm
	SOW[7,9]	600								

Trade Name	Type Letter	Voltage	AWG or kcmil	Number of Conductors	Insulation	AWG or kcmil	Nominal Insulation Thickness		Braid on Each Conduc-tor	Co
							mm	mils		
	SOO[7]	600			Oil-resistant thermoset	14–9 8–2	1.14 1.52	45 60		
	SOOW[7,9]	600								
All thermoset parallel cord	SP-1	300	20–18	2 or 3	Thermoset	20–18	0.76	30	None	None
	SP-2	300	18–16			18-16	1.14	45		
	SP-3	300	18–10			18–16 15–14 12 10	1.52 2.03 2.41 2.80	60 80 95 110		
All elastomer (thermo-plastic) parallel cord	SPE-1[8]	300	20-18	2 or 3	Thermoplastic elastomer	20–18	0.76	30	None	None
	SPE-2[8]	300	18–16			18–16	1.14	45		
	SPE-3[8]	300	18–10			18–16 15–14 12 10	1.52 2.03 2.41 2.80	60 80 95 110		
All thermoplastic parallel cord	SPT-1	300	20–18	2 or 3	Thermoplastic	20–18	0.76	30	None	None
	SPT-1W[9]	300		2						
	SPT-2	300	18–16	2 or 3		18–16	1.14	45		
	SPT-2W[9]	300		2						

Trade Name	Type Letter	Voltage	AWG or kcmil	Number of Conductors	Insulation	AWG or kcmil	Nominal Insulation Thickness		Braid on Each Conduc-tor	Co
							mm	mils		
	SPT-3	300	18–10	2 or 3		18–16 15–14 12 10	1.52 2.03 2.41 2.80	60 80 95 110		
Range, dryer cable	SRD	300	10–4	3 or 4	Thermoset	10–4	1.14	45	None	Ther
	SRDE	300	10–4	3 or 4	Thermoplastic elastomer				None	Ther plast elast
	SRDT	300	10–4	3 or 4	Thermoplastic				None	Ther plast
Hard service cord	ST[7]	600	18–2	2 or more	Thermoplastic	18–15 14–9 8–2	0.76 1.14 1.52	30 45 60	None	Ther plast
	STW[7,9]	600								
	STO[7]	600								Oil-r therr lastic
	STOW[7, 9]	600								
	STOO[7]	600			Oil-resistant thermoplastic					
	STOOW[7]	600								
Vacuum cleaner cord	SV	300	18–16	2 or 3	Thermoset	18–16	0.38	15	None	Ther
	SVE	300			Thermoplastic elastomer					Ther plast elast
	SVEO	300								Oil-r therr plast

Trade Name	Type Letter	Voltage	AWG or kcmil	Number of Conductors	Insulation	AWG or kcmil	Nominal Insulation Thickness		Braid on Each Conduc-tor	Co
							mm	mils		
										elast
	SVEOO	300			Oil-resistant thermoplastic elastomer					
	SVO	300			Thermoset					Oil-r therm
	SVOO	300			Oil-resistant thermoset					Oil-r therm
	SVT	300			Thermoplastic					Ther
	SVTO	300			Thermoplastic					Oil-r therm plast
	SVTOO	300			Oil-resistant thermoplastic					
Parallel tinsel cord	TPT[11]	300	27	2	Thermoplastic	27	0.76	30	None	Ther plast
Jacketed tinsel cord	TST[11]	300	27	2	Thermoplastic	27	0.38	15	None	Ther plast
Portable power cable	W[7]	2000	12–500 501–1000	1–6 1	Thermoset	12–2 1–4/0 250–500 501–1000	1.52 2.03 2.41 2.80	60 80 95 110		Oil-r therm

Notes:

All types listed in Table 400.4 shall have individual conductors twisted together, except for Types HPN, SP-1, SP-2, SP-3, SPE-1, SPE-2, SPE-3, SPT-1, SPT-2, SPT-3, SPT-1W, SPT-2W, TPT, NISP-1, NISP-2, NISPT-1, NISPT-2, NISPE-1, NISPE-2, and three-conductor parallel versions of SRD, SRDE, and SRDT.

The individual conductors of all cords, except those of heat-resistant cords, shall have a thermoset or thermoplastic insulation, except that the equipment grounding conductor, where used, shall be in accordance with 400.23(B).

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

[2]Elevator traveling cables for operating control and signal circuits shall contain nonmetallic fillers as necessary to maintain concentricity. Cables shall have steel supporting members as required for suspension by 620.41. In locations subject to excessive moisture or corrosive vapors or gases, supporting members of other materials shall be permitted. Where steel supporting members are used, they shall run straight through the center of the cable assembly and shall not be cabled with the copper strands of any conductor.

In addition to conductors used for control and signaling circuits, Types E, EO, ETP, and ETT elevator cables shall be permitted to incorporate in the construction one or more 20 AWG telephone conductor pairs, one or more coaxial cables, or one or more optical fibers. The 20 AWG conductor pairs shall be permitted to be covered with suitable shielding for telephone, audio, or higher frequency communications circuits; the coaxial cables shall consist of a center conductor, insulation, and a shield for use in video or other radio frequency

communications circuits. The optical fiber shall be suitably covered with flame-retardant thermoplastic. The insulation of the conductors shall be rubber or thermoplastic of a thickness not less than specified for the other conductors of the particular type of cable. Metallic shields shall have their own protective covering. Where used, these components shall be permitted to be incorporated in any layer of the cable assembly but shall not run straight through the center.

[3]Insulations and outer coverings that meet the requirements as flame retardant, limited smoke, and are so listed, shall be permitted to be marked for limited smoke after the *Code* type designation.

[4]Elevator cables in sizes 20 AWG through 14 AWG are rated 300 volts, and sizes 10 AWG through 2 AWG are rated 600 volts. 12 AWG is rated 300 volts with a 0.76 mm (30 mil) insulation thickness and 600 volts with a 1.14 mm (45 mil) insulation thickness.

[5]Conductor size for Types EV, EVJ, EVE, EVJE, EVT, and EVJT cables apply to nonpower-limited circuits only. Conductors of power-limited (data, signal, or communications) circuits may extend beyond the stated AWG size range. All conductors shall be insulated for the same cable voltage rating.

[6]Insulation thickness for Types EV, EVJ, EVEJE, EVT, and EVJT cables of nylon construction is indicated in parentheses.

[7]Types G, G-GC, S, SC, SCE, SCT, SE, SEO, SEOO, SEW, SEOW, SEOOW, SO, SOO, SOW, SOOW, ST, STO, STOO, STW, STOW, STOOW, PPE, and W shall be permitted for use on theater stages, in garages, and elsewhere where flexible cords are permitted by this *Code*.

[8]The third conductor in Type HPN shall be used as an equipment grounding conductor only. The insulation of the equipment grounding conductor for Types SPE-1, SPE-2, SPE-3, SPT-1, SPT-2, SPT-3, NISPT-1, NISPT-2, NISPE-1, and NISPE-2 shall be permitted to be thermoset polymer.

[9]Cords that comply with the requirements for outdoor cords and are so listed shall be permitted to be designated as weather and water resistant with the suffix “W” after the *Code* type designation. Cords with the “W” suffix are suitable for use in wet locations and are sunlight resistant.

[10]The required outer covering on some single-conductor cables may be integral with the insulation.

[11]Types TPT and TST shall be permitted in lengths not exceeding 2.5 m (8 ft) where 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.

Supplemental Information

File Name	Description	Approved
Revised_Table_400.4_sls.docx	clean version--for staff use	✓
Panel_6_FR-7917_Table_400.4_leg_changes.docx	For staff use	✓

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jan 11 10:07:35 EST 2018

Committee Statement and Meeting Notes

Committee Statement: Since a new outdoor cable type has been developed for the industry regarding heaters then the NEC should reflect this addition.

Per the work of the grounding task group, this language should include the word “equipment” grounding conductor as this best describes the function of this conductor.

The product standard is being updated to allow 1000 volt rated electric vehicle cable.

The submitter has identified a typo in the NEC.

Response Message:

Public Input No. 1643-NFPA 70-2017 [Section No. 400.4]

Public Input No. 2059-NFPA 70-2017 [Section No. 400.4]

Public Input No. 2395-NFPA 70-2017 [Section No. 400.4]

Public Input No. 1636-NFPA 70-2017 [Section No. 400.4]

Editorial Comment

Click here

First Revision No. 7907-NFPA 70-2018 [Section No. 400.12]

400.12 Uses Not Permitted.

Unless specifically permitted in 400.10, flexible cords, flexible cables, ~~flexible~~ cord sets, and power supply cords shall not be used for the following:

(1) As a substitute for the fixed wiring of a structure

(2) Where run through holes in walls, structural ceilings, suspended ceilings, dropped ceilings, or floors

(3) Where run through doorways, windows, or similar openings

(4) Where attached to building surfaces

Exception to (4): Flexible cord and flexible cable shall be permitted to be attached to building surfaces in accordance with 368.56(B) and 590.4 .

(5) Where concealed by walls, floors, or ceilings or located above suspended or dropped ceilings

Exception to (5): Flexible cord and flexible cable shall be permitted if contained within an enclosure for use in other spaces used for environmental air as permitted by 300.22(C)(3).

(6) Where installed in raceways, except as otherwise permitted in this *Code*

(7) Where subject to physical damage

Informational Note: For proper application see UL 817, *Cord Sets and Power-Supply Cords* , and UL 62, *Flexible Cords and Cables* .

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jan 11 09:36:08 EST 2018

Committee Statement and Meeting Notes

Committee Statement: The Informational note is appropriately located under 400.12 and was revised for clarity. Since article 400 is “flexible cords and flexible cables”, 400.12 should include both in its description of uses not permitted. Article 590 should be included in the exception that Article 400 flexible cords and flexible cables may be supported by the building surface but in the submitter's substantiation it is claimed that extension cords can be used for branch circuits and feeders which is not permissible.

Response Message:

Committee Notes:

Date	Submitted By	
Jan 11, 2018	NEC-CMP Panel 06	The exception that is showing underlined is not new. Remove underline.

Public Input No. 1676-NFPA 70-2017 [Section No. 400.10]

Public Input No. 1601-NFPA 70-2017 [Section No. 400.1]

Public Input No. 430-NFPA 70-2017 [Section No. 400.12]

Public Input No. 3258-NFPA 70-2017 [Section No. 400.12]

Public Input No. 325-NFPA 70-2017 [Section No. 400.12]

Public Input No. 2167-NFPA 70-2017 [Section No. 400.12]

Public Input No. 2684-NFPA 70-2017 [Section No. 400.12]

Public Input No. 2100-NFPA 70-2017 [Section No. 400.12]

Public Input No. 1674-NFPA 70-2017 [Section No. 400.1]

Editorial Comment

Click here

First Revision No. 7982-NFPA 70-2018 [Section No. 402.3]

402.3 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 service at 600 volts, nominal, unless otherwise specified.

Informational Note: Thermoplastic insulation may stiffen at temperatures lower than -10°C (+14°F). Thermoplastic insulation may also be deformed at normal temperatures where subjected to pressure, such as at points of support.

Table 402.3 Fixture Wires

Name	Type Letter	Insulation	AWG	Thickness of Insulation		Outer Covering	Maximum Operating Temperature	Application Provisions
				mm	mils			
Heat-resistant rubber-covered fixture wire — flexible stranding	FFH-2 FFHH-2	Heat-resistant rubber or ~~Cross~~ cross - linked synthetic polymer	18–16 ~~18–16~~	0.76 ~~0.76~~	30 ~~30~~	Nonmetallic covering	75°C (167°F) 90°C (194°F)	Fixture wiring
ECTFE — solid or 7-strand	HF	Ethylene chloro-trifluoroethylene	18–14	0.38	15	None	150°C (302°F)	Fixture wiring
ECTFE — flexible stranding	HFF	Ethylene chlorotrifluo-roethylene	18–14	0.38	15	None	150°C (302°F)	Fixture wiring
Tape insulated fixture wire — solid or 7-strand	KF-1	Aromatic polyimide tape	18–10	0.14	5.5	None	200°C (392°F)	Fixture wiring — limited to 300 volts
	KF-2	Aromatic polyimide tape	18–10	0.21	8.4	None	200°C (392°F)	Fixture wiring
Tape insulated fixture wire — flexible stranding	KFF-1	Aromatic polyimide tape	18–10	0.14	5.5	None	200°C (392°F)	Fixture wiring — limited to 300 volts
	KFF-2	Aromatic polyimide tape	18–10	0.21	8.4	None	200°C (392°F)	Fixture wiring
Perfluoro-alkoxy — solid or 7-strand (nickel or nickel-coated copper)	PAF	Perfluoro-alkoxy	18–14	0.51	20	None	250°C (482°F)	Fixture wiring (nickel or nickel-coated copper)
Perfluoro-alkoxy — flexible stranding	PAFF	Perfluoro-alkoxy	18–14	0.51	20	None	150°C (302°F)	Fixture wiring
Fluorinated ethylene propylene fixture wire — solid or 7-strand	PF	Fluorinated ethylene propylene	18–14	0.51	20	None	200°C	Fixture wiring

Name	Type Letter	Insulation	AWG	Thickness of Insulation		Outer Covering	Maximum Operating Temperature (392°F)	Application Provisions
				mm	mils			
Fluorinated ethylene propylene fixture wire — flexible stranding	PFF	Fluorinated ethylene propylene	18–14	0.51	20	None	150°C (302°F)	Fixture wiring
Fluorinated ethylene propylene fixture wire — solid or 7-strand	PGF	Fluorinated ethylene propylene	18–14	0.36	14	Glass braid	200°C (392°F)	Fixture wiring
Fluorinated ethylene propylene fixture wire — flexible stranding	PGFF	Fluorinated ethylene propylene	18–14	0.36	14	Glass braid	150°C (302°F)	Fixture wiring
Extruded polytetrafluoroethylene — solid or 7-strand (nickel or nickel-coated copper)	PTF	Extruded polytetrafluo-roethylene	18–14	0.51	20	None	250°C (482°F)	Fixture wiring (nickel or nickel-coated copper)
Extruded polytetrafluoroethylene — flexible stranding 26-36 (AWG silver or nickel-coated copper)	PTFF	Extruded polytetrafluo-roethylene	18–14	0.51	20	None	150°C (302°F)	Fixture wiring (silver or nickel-coated copper)
Heat-resistant rubber-covered fixture wire — solid or 7-strand	RFH-1	Heat-resistant rubber	18	0.38	15	Nonmetallic covering	75°C (167°F)	Fixture wiring — limited to 300 volts
	RFH-2	Heat-resistant rubber Cross-linked synthetic polymer	18–16	0.76	30	None or non-metallic covering	75°C (167°F)	Fixture wiring
Heat-resistant cross-linked synthetic polymer-insulated fixture wire — solid or 7-strand	RFHH-2* RFHH-3*	Cross-linked synthetic polymer	18–16 18–16	0.76 1.14	30 45	None or non-metallic covering	90°C (194°F)	Fixture wiring
Silicone insulated fixture wire — solid or 7-strand	SF-1	Silicone rubber	18	0.38	15	Nonmetallic covering	200°C (392°F)	Fixture wiring — limited to 300 volts
	SF-2	Silicone rubber	18–12 10	0.76 1.14	30 45	Nonmetallic covering	200°C (392°F)	Fixture wiring

Name	Type Letter	Insulation	AWG	Thickness of Insulation		Outer Covering	Maximum Operating Temperature	Application Provisions
				mm	mils			
Silicone insulated fixture wire — flexible stranding	SFF-1	Silicone rubber	18	0.38	15	Nonmetallic covering	150°C (302°F)	Fixture wiring — limited to 300 volts
	SFF-2	Silicone rubber	18–12 10	0.76 1.14	30 45	Nonmetallic covering	150°C (302°F)	Fixture wiring
Thermoplastic covered fixture wire — solid or 7-strand	TF*	Thermoplastic	18–16	0.76	30	None	60°C (140°F)	Fixture wiring
Thermoplastic covered fixture wire — flexible stranding	TFF*	Thermoplastic	18–16	0.76	30	None	60°C (140°F)	Fixture wiring
Heat-resistant thermoplastic covered fixture wire — solid or 7-strand	TFN*	Thermoplastic	18–16	0.38	15	Nylon-jacket-ed or equivalent	90°C (194°F)	Fixture wiring
Heat-resistant thermoplastic covered fixture wire — flexible stranded	TFFN*	Thermoplastic	18–16	0.38	15	Nylon-jacket-ed or equivalent	90°C (194°F)	Fixture wiring
Cross-linked polyolefin insulated fixture wire — solid or 7-strand	XF*	Cross-linked polyolefin	18–14 12-10	0.76 1.14	30 45	None	150°C (302°F)	Fixture wiring — limited to 300 volts
Cross-linked polyolefin insulated fixture wire — flexible stranded	XFF*	Cross-linked polyolefin	18–14 12–10	0.76 1.14	30 45	None	150°C (302°F)	Fixture wiring — limited to 300 volts
Modified ETFE — solid or 7-strand	ZF	Modified ethylene tetrafluoro-ethylene	18–14	0.38	15	None	150°C (302°F)	Fixture wiring
~~Flexible~~ Modified ETFE — flexible stranding	ZFF	Modified ethylene tetrafluoro-ethylene	18–14	0.38	15	None	150°C (302°F)	Fixture wiring
High temp. modified ETFE— solid or 7-strand	ZHF	Modified ethylene tetrafluoro-ethylene	18–14	0.38	15	None	200°C (392°F)	Fixture wiring

*Insulations and outer coverings that meet the requirements of flame retardant, limited smoke, and are so listed, shall be permitted to be marked for limited smoke after the *Code* type designation.

Supplemental Information

File Name	Description	Approved
Revised_Table_402.3.docx	Revised Table 402.3. For staff use	✓

Submitter Information Verification

Submitter Full Name: NEC-CMP Panel 06
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Street Address:
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Zip:
Submittal Date: Thu Jan 11 15:06:56 EST 2018

Committee Statement and Meeting Notes

Committee Statement: A new type of heat-resistant rubber-covered fixture wire — flexible stranding (FFHH-2) for 90 deg C was added to the table as it is new to the industry and will be recognized by the product standards. The other revisions to the table were editorial.

Response Message:

Editorial Comment

Click here

First Revision No. 7971-NFPA 70-2018 [Definition: Example D7 Sizing of Service Conductors for Dwe...]

Example D7 Sizing of Service Conductors for Dwelling(s)

Service conductors and feeders for certain dwellings are permitted to be sized in accordance with ~~310.15(B)(7)~~ 310.12 .

With No Required Adjustment or Correction Factors. If a 175-ampere service rating is selected, a service conductor is then sized as follows:

175 amperes × 0.83 = 145.25 amperes per ~~310.15(B)(7)~~ 310.12 .

If no other adjustments or corrections are required for the installation, then, in accordance with ~~Table 310.15(B)(16)~~ Table 310.16 , a 1/0 AWG Cu or a 3/0 AWG Al meets this rating at 75°C (167°F).

With Required Temperature Correction Factor.

If a 175-ampere service rating is selected, a service conductor is then

175 amperes × 0.83 = 145.25 amperes per ~~310.15(B)(7)~~ 310.12 .

If the conductors are installed in an ambient temperature of ~~40°C~~ 38°C (~~104°F~~ 100°F), the conductor ampacity must be multiplied by the appropriate correction factor in ~~Table 310.15(B)(2)(a)~~ Table 310.15(B)(1) . In this case, we will use an XHHW-2 conductor, so we use a correction factor of 0.91 to find the minimum conductor ampacity and size:

145.25/.91 = 159.6 amperes

In accordance with ~~Table 310.15(B)(16)~~ Table 310.16 , a 2/0 AWG Cu or a 4/0 AWG Al would be required.

If no temperature correction or ampacity adjustment factors are required, the following table includes conductor sizes calculated using the requirements in ~~310.15(B)(7)~~ 310.12 . This table is based on 75°C terminations and without any adjustment or correction factors.

Service or Feeder Rating (Amperes)	Conductor (AWG or kcmil)	
	Copper	Aluminum or Copper-Clad Aluminum
100	4	2
110	3	1
125	2	1/0
150	1	2/0
175	1/0	3/0
200	2/0	4/0
225	3/0	250
250	4/0	300
300	250	350
350	350	500
400	400	600

Submitter Information Verification

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Zip:

Submittal Date: Thu Jan 11 13:57:40 EST 2018

Committee Statement and Meeting Notes

Committee Statement: The table references were updated to align with the reorganization of Article 310. The ambient temperature value was changed to avoid confusion with table headings.

Response Message: