

Reprinted with permission from NFPA 70-1968, the National Electrical Code®, Copyright© 1967, National Fire Protection Association, Quincy, MA 02269. This reprinted material is not the complete and official position of the National Fire Protection Association, on the referenced subject which is represented only by the standard in its entirety.

National Electrical Code® and NEC® are registered trademarks of the National Fire Protection Association, Inc., Quincy, MA 02269.

## **ARTICLE 310 - CONDUCTORS FOR GENERAL WIRING**

### **310-1. General.**

(a) The purpose of this Article is to assure that conductors have mechanical strength, insulation, and ampacity adequate for the particular conditions under which they are to be used.

(b) Conductors shall be insulated, except when covered or bare conductors are specifically permitted in this Code.

(c) The provisions of this Article are not intended to apply to conductors which form an integral part of equipment such as motors, motor controllers, and the like, or which are provided for elsewhere in this Code.

### **310-2. Application and Construction.**

(a) **Conductor Application.** Conductor insulations as specified in the following Table 310-2(a) may be installed for any of the wiring methods recognized in this Chapter, except as otherwise provided for in the Table or in Section 310-3, or as otherwise specified in this Code. They are suitable for 600 volts unless otherwise specified.

(b) **Conductor Construction.** Insulated conductors for use at 600 volts or less shall conform to the provisions of Table 310-2(b).

(c) **Marking.** Insulated wires, cables and cords of all kinds except paper-insulated wire shall have a continuous distinctive marking so that their maker may be readily identified. All wires, cables and cords shall also be plainly tagged or marked as follows:

(1) The maximum working voltage for which the wire was tested or approved. This may be omitted for asbestos-covered switchboard wires.

(2) The words "National Electrical Code Standard®," or "NEC® Std."

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

(4) Month and year when manufactured.

(5) The proper type letter for the particular style of wire or cable as given in the following section.

**(d) Surface Marking.** A durable marking on the surface shall be provided at intervals not exceeding 24 inches, by which the maker may be identified. Such marking shall be the manufacturer's name, trade-mark, or other distinctive marking by which the organization responsible for the product may be identified. The marking shall also include the type letters as specified in Article 310, Table 310-2(b) and Articles 336, 338 and 339, the size AWG or circular mils and the maximum voltage on the following types of wire and cable rated 600 volts or less:

(1) Single conductor only, rubber insulated and thermoplastic insulated for General Wiring.

(2) Nonmetallic Sheathed Cable.

(3) Service-Entrance Cable.

(4) Underground Feeder and Branch Circuit Cable.

All other types of wire and cable, flexible cords, fixture wires, switchboard wires, and any of the above types with a metallic covering are not required to have a marking on the surface.

**(e) Classification.** In addition to the type letters specified in Table 310-2(b), the following letters shall apply:

(1) A type letter or letters used alone indicates a single insulated conductor.

(2) The letter "D" used as a suffix indicates a twin wire with two insulated conductors laid parallel under an outer nonmetallic covering.

(3) The letter "M" used as a suffix indicates an assembly of two or more insulated conductors twisted together under an outer nonmetallic covering.

(4) The letter "L" used as a suffix indicates an outer covering of lead.

**(5) Voltage.** Type letters, when used alone, indicate conductors for use at not more than 600 volts. Conductors for use at higher voltages shall be indicated by adding numerical suffixes to the type letters as follows:

- 10 - for use at not more than 1000 volts.
- 20 - for use at not more than 2000 volts.
- 30 - for use at not more than 3000 volts.
- 40 - for use at not more than 4000 volts.
- 50 - for use at not more than 5000 volts.

The working voltages referred to in the Table are the operating voltages between phases of single and two-phase systems, and three-phase systems with grounded or ungrounded neutral.

(6) All NEC<sup>®</sup> standard conductors shall be examined and tested at the factory and, if approved, shall be labeled before shipment.

**(f) Identification of Insulation.** All rubber-insulated conductors and all thermoplastic-insulated conductors, No. 18 and larger, shall have a readily recognizable durable marking to indicate the type of insulation; except that single-conductor, code-rubber insulated conductors having a lead sheath; and multi-conductor cables, metal-clad cable, and non-metallic-sheathed cable having code-rubber or nonmoisture-resistant thermoplastic-insulated conductors, need not be so marked.

**(g) Identified Conductors.** Single insulated conductors of No. 6 or smaller, intended for use as identified conductors of circuits shall have an outer identification of a white or natural gray color. Twin and twisted-pair conductors and three-conductor cables shall have one conductor, and four-conductor cables shall have at least one conductor identified in this manner. Multiple conductor flat cable No. 4 AWG or larger may employ an external ridge on the identified conductor.

Exception No. 1 - Multiple-conductor varnished cloth insulated cables.

Exception No. 2 - Fixture wires as outlined below.

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

For fixture wires the identification shall be as above, or by means of (1) stripes, or (2) by the means described in Sections 400-13 (a), (b), (c), (d) and (e).

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

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

**(h) Unidentified Conductors.** Single conductors, intended for use as unidentified conductors, and conductors other than the identified conductor in multi-conductor cables, shall be finished to show a color or combination of colors other than, and contrasting with, white or natural gray. The colors contrasting with white or natural gray, may be provided by means of an approved stripe or stripes on black conductors. For identification requirements for conductors larger than No. 6 see Section 200-6(b).

**(i) Insulation Thickness - Over 600 Volts.** The thickness of insulation for conductors for use at over 600 volts shall conform to Tables 310-2 (i-1 thru i-4):

**Table 310-2(a). Conductor Application**

Trade Name Provisions	Type Letter	Maximum	Application
		Operating Temperature	
Rubber-Covered Fixture Wire	*RF-1	60°C 140°F	Fixture wiring. Limited to 300 V.
Solid or 7-Strand	*RF-2	60°C 140°F	Fixture wiring, and as permitted in Section 310-8.
Rubbered-Covered Fixture Wire	*FF-1	60°C 140°F	Fixture wiring. Limited to 300 V.
Flexible Stranding	*FF-2	60°C 140°F	Fixture wiring, and as permitted in Section 310-8.
Heat-Resistant Rubber-Covered Fixture Wire	*RFH-1	75°C 167°F	Fixture wiring. Limited to 300 V.
Solid or 7-Strand	*RFH-2	75°C 167°F	Fixture wiring, and as permitted in Section 310-8.
Heat-Resistant Rubber-Covered Fixture Wire	*FFH-1	75°C 167°F	Fixture wiring. Limited to 300 V.
Flexible Stranding	*FFH-2	75°C 167°F	Fixture wiring, and as permitted in Section 310-8.
Thermoplastic-Covered Fixture Wire - Solid or	*TF	60°C 140°F	Fixture wiring, and as permitted in Section 310-8, & for circuits

as  
Stranded  
725

permitted in Article

---

Table 310-2(a). Conductor Application - Continued

Trade Name Provisions	Type	Maximum Operating	Application
	Letter	Temperature	
Thermoplastic-Covered Fixture Wire - Flexible as Stranding 725	*TFF	60°C 140°F	Fixture wiring, and as permitted in Section 310-8, & for circuits permitted in Article
Heat Resistant Thermoplastic - Covered Fixture Wire - Solid or Stranded	*TFN	90°C	Fixture wiring, and as permitted in Section 310-8.
Heat Resistant, Thermoplastic - Covered Fixture Wire - Flexible Stranding	*TFFN	90°C	Fixture wiring, and as permitted in Section 310-8.
Cotton-Covered, Heat-Resistant, Fixture Wire	*CF	90°C 194°F	Fixture wiring. Limited to 300 V.
Asbestos-Covered Heat-Resistant, Fixture Wire	*AF	150°C 302°F	Fixture wiring. Limited to 300V & Indoor Dry Location.
Fluorinated Ethylene Propylene Fixture Wire Solid or 7 Strand	*PF *PGF	150°C 302°F	Fixture Wiring and as permitted in Section 310-8.
Fluorinated Ethylene Propylene Fixture Wire	*PFF *PGFF	150°C 302°F	Fixture Wiring and as permitted in Section 310-8.
Silicone Rubber Insulated Fixture Wire Solid or 7 Strand	*SF-1 *SF-2	200°C 392°F 200°C 392°F	Fixture Wiring. Limited to 300 V. Fixture wiring and as permitted in Section 310-8.

Table 310-2(a). Conductor Application - Continued

Trade Name Provisions	Type Letter	Maximum Operating Temperature		Application
Silicone Rubber Insulated Fixture Wire	*SFF-1	150°C 302°F		Fixture wiring. Limited to 300 V.
Flexible Stranding	*SFF-2	150°C 302°F		Fixture wiring and as permitted in Section 310-8.
Heat-Resistant Rubber	RH	75°C 167°F		Dry locations.
Heat-Resistant Rubber	RHH	90°C 194°F		Dry locations.
Moisture and Heat-Resistant Rubber	RHW	75°C 167°F		Dry and wet locations. For over 2000 volts, insulation shall be ozone-resistant.
Heat-Resistant Latex Rubber	RUH	75°C		Dry locations.
Moisture Resistant Latex Rubber	RJW	60°C 140°F		Dry and wet locations.
Thermoplastic	T	60°C 140°F		Dry locations.
Moisture- Resistant Thermoplastic	TW	60°C 140°F		Dry and wet locations.
Heat-Resistant Thermoplastic	THHN	90°C 194°F		Dry locations.
Moisture and Heat-Resistant Thermoplastic	THW	75°C 167°F		Dry and wet locations.
Moisture and Heat-Resistant Thermoplastic	THWN	75°C 167°F		Dry and wet locations.

H

Table 310-2(a). Conductor Application - Continued

Trade Name Provisions	Type Letter	Maximum	Application
		Operating Temperature	
Moisture and Heat-Resistant Cross-Linked Thermosetting Polyethylene	XHHW	90°C 194°F	Dry locations.
		75°C 167°F	Wet locations.
Moisture-, Heat- & Oil-Resistant Thermoplastic	MTW	60°C 140°F	Wet locations, Machine Toll Wiring. (see Article 670 and NFPA Standard No. 79)
		90°C 194°F	Dry locations. Machine Toll Wiring. (see Article 670 and NFPA Standard No. 79).
Moisture-, Heat- & Oil-Resistant Thermoplastic	THW-MTW	75°C 167°F	Dry and wet locations.
		90°C 194°F	Special applications within electric discharge lighting equipment. Limited to 1000 open-circuit volts or less. (Size 14-8 only.)
Thermoplastic and Asbestos	TA	90°C 194°F	Switchboard wiring only.
Thermoplastic and Fibrous Outer Braid	TBS	90°C 194°F	Switchboard wiring only.
Synthetic Heat-Resistant	SIS	90°C 194°F	Switchboard wiring only.
Mineral Insulation (Metal Sheathed)	MI	85°C 185°F	Dry and wet locations with Type O termination fittings.
		250°C 482°F	For special application.

Table 310-2(a). Conductor Application - Continued

Trade Name Provisions	Type Letter	Maximum	Application
		Operating Temperature	
Silicone-Asbestos	SA	90°C 194°F	Dry locations.
		125°C 257°F	For special application.
Fluorinated Ethylene Propylene	EEP or FEPB	90°C 194°F	Dry locations.
		200°C 392°F	Dry locations - special applications.
Varnished Cambric	V	85°C 185°F	Dry locations only. Smaller than No. 6 by special permission.
Asbestos and Varnished Cambric	AVA	110°C 230°F	Dry locations only.
Asbestos and Varnished Cambric	AVL	110°C	Dry and wet locations.
Asbestos and Varnished Cambric	AVB	90°C 194°F	Dry locations only.
Asbestos	A	200°C 392°F	Dry locations only. Only for leads within apparatus or within raceways connected to apparatus. Limited to 300 V.
Asbestos	AA	200°C 392°F	Dry locations only. Only for leads within apparatus or within raceways connected to apparatus or as open wiring. Limited to 300 V.

Table 310-2(a). Conductor Application - Continued

Trade Name Provisions	Type Letter	Maximum	Application
		Operating Temperature	
Asbestos	AI	125°C 257°F	Dry locations only. Only for leads within apparatus or within raceways connected to apparatus. Limited to 300 V.
Asbestos	AIA	125°C 257°F	Dry locations only. Only for leads within apparatus or within raceways connected to apparatus or as open wiring.
Paper		85°C 185°F	For underground service conductors, or by special permission.

\*Fixture wires are not intended for installation as branch circuit conductors except as permitted in Article 725.

Table 310-2(b). Conductor Insulations

Trade Name	Type Letter	Insulation	Thickness of Insulation		Outer Covering
Heat-Resistant nonmetallic	RH RHH	Heat Resistant Rubber	**14-12....2/64	Inch	*Moisture-resistant, flame-retardant, covering
			10.....3/64	Inch	
			8-2.....4/64	Inch	
			1-4/0.....5/64	Inch	
			213-500....6/64	Inch	
			501-1000...7/64	Inch	
1001-2000..8/64	Inch				
Moisture and Heat-Resistant nonmetallic	RHW	Moisture and Heat Resistant Rubber	14-10.....3/64	Inch	*Moisture-resistant, flame-retardant, Inch covering
			8-2.....4/64	Inch	
			1-4/0.....5/64	Inch	
			213-500....6/64	Inch	
			501-1000...7/64	Inch	
			1001-2000..8/64	Inch	
Heat-Resistant Latex Rubber nonmetallic	RUH	90% Unmilled, Grainless Rubber	14-10.....18	Mils	Moisture-resistant, flame-retardant, covering
			8-2.....25	Mils	
Moisture-Resistant Latex Rubber nonmetallic	RUW	90% Unmilled, Grainless Rubber	14-10.....18	Mils	Moisture-resistant, flame-retardant, covering
			8-2.....25	Mils	
Thermo-plastic	T	Flame-Retardant Thermo-plastic Compound	14-10.....2/64	Inch	None
			8.....3/64	Inch	
			6-2.....4/64	Inch	
			1-4/0.....5/64	Inch	
			213-500....6/64	Inch	
			501-1000...7/64	Inch	
			1001-2000..8/64	Inch	
Moisture-Resistant Thermo-plastic	TW	Flame-Retardant, Moisture-Resistant Thermo-plastic	14-10.....2/64	Inch	None
			8.....3/64	Inch	
			6-2.....4/64	Inch	
			1-4/0.....5/64	Inch	
			213-500....6/64	Inch	
			501-1000...7/64	Inch	
			1001-2000..8/64	Inch	

\*Outer covering is not required over rubber insulations which have been specifically approved for the purpose.

\*\*For 14-12 sizes RHH shall be 3/64 inch thickness insulation. For insulated aluminum conductors, the minimum size is No. 12 AWG.

Table 310-2(b). Conductor Insulations - Continued

Trade Name	Type Letter	Insulation	Thickness of Insulation		Outer Covering			
Heat-Resistant Thermo-plastic	THHN	Flame-Retardant	14-12.....	15 Mils	Nylon Jacket			
		Heat Resistant	10.....	20 Mils				
		Thermo-plastic	8-6.....	30 Mils				
		Thermo-plastic	4-2.....	40 Mils				
		Thermo-plastic	1-4/0.....	50 Mils				
			250-500 MCM..	60 Mils				
Moisture and Heat Resistant Thermo-plastic	THW	Flame-Retardant, Moisture and Heat-Resistant Thermo-plastic	14-10.....	3/64 Inch	None			
			8-2.....	4/64 Inch				
			1-4/0.....	5/64 Inch				
			213-500....	6/64 Inch				
			501-1000...	7/64 Inch				
			1001-2000..	8/64 Inch				
Moisture and Heat-Resistant Thermo-plastic	THWN	Flame-Retardant	14-12.....	15 Mils	Nylon Jacket			
		Moisture and Heat-Resistant Thermo-plastic	10.....	20 Mils				
		Moisture and Heat-Resistant Thermo-plastic	8-6.....	30 Mils				
		Moisture and Heat-Resistant Thermo-plastic	4-2.....	40 Mils				
		Moisture and Heat-Resistant Thermo-plastic	1-4/0.....	50 Mils				
			250-500 MCM..	60 Mils				
Moisture and Heat-Resistant Cross-Linked Thermo-plastic Polyethylene	XHHW	Flame-Retardant	14-10.....	30 Mils	None			
		Cross-Linked Polyethylene	8-2.....	45 Mils				
		Cross-Linked Polyethylene	1-4/0.....	55 Mils				
		Cross-Linked Polyethylene	213-500.....	65 Mils				
		Cross-Linked Polyethylene	501-1000.....	80 Mils				
			1001-2000....	95 Mils				
Moisture-, Heat & Oil Resistant Thermo-plastic	MTW	Flame-Retardant, Moisture-, Heat & Oil Resistant Thermo-plastic		(A) 22-12...2/64	15 Mils	(A) None		
				10.....2/64	20 Mils	(B) Nylon Jacket		
				8.....3/64	30 Mils			
				6.....4/64	30 Mils			
				4-2.....5/64	40 Mils			
				1-4/0...6/64	50 Mils			
				213-500 MCM...6/64	60 Mils			
				501-1000 MCM...7/64	70 Mils			

For insulated aluminum conductors, the minimum size is #12 AWG. See Tables 310-14 and 310-15.

Table 310-2(b). Conductor Insulations - Continued

Trade Name	Type Letter	Insulation	Thickness of Insulation		Outer Covering	
Moisture-, Heat & Oil Resistant Thermo-plastic	THW- MTW	Flame-Retardant,	14-10.....	3/64	None	
		Moisture-,	8-2.....	4/64		
		Heat & Oil-	1-4/0.....	5/65		
		Resistant	213-500.....	6/64		
		Thermo-plastic	501-1000.....	7/64		
		1001-2000.....	8/64			
Thermo-plastic & retardant, Asbestos	TA	Thermo-plastic & Asbestos	Th'pl' 14-8	Asb. -20	Flame- 20 Mils	
			6-2 -30 Mils	25 Mils	non-metallic covering	
		1-4/0-40	Mils	30 Mils		
Thermo-plastic & Fibrous Braid	TBS	Thermo-plastic	14-10.....	2/64	Inch	Flame-retardant, non-metallic covering
			8.....	3/64	Inch	
			6-2.....	4/64	Inch	
			1-4/0.....	5/64	Inch	
Synthetic Heat-Resistant	SIS	Heat-Resistant Rubber	14-10.....	2/64	Inch	None
			8.....	3/64	Inch	
			6-2.....	4/64	Inch	
			1-4/0.....	5/64	Inch	
Mineral-Insulated Metal-Sheathed	MI	Magnesium Oxide	16-4.....	50	Mils	Copper
			3-250	MCM....	55	
Silicone-Asbestos	SA	Silicone Rubber	14-10.....	3/64	Inch	Asbestos or glass
			8-2.....	4/64	Inch	
			1-4/0.....	5/64	Inch	
			213-500....	6/64	Inch	
			501-1000...	7/64	Inch	
		1001-2000..	8/64	Inch		
Fluorinated Ethylene Propylene	FEB	Fluorinated Ethylene Propylene	14-10.....	20	Mils	None
			8-2.....	30	Mils	
			14-8.....	14	Mils	
	FEPB	Fluorinated Ethylene Propylene	6-2.....	14	Mils	Asbestos braid

For insulated aluminum conductors, the minimum size is #12 AWG. See Tables 310-14 and 310-15.

Table 310-2(b). Conductor Insulations - Continued

Trade Name	Type Letter	Insulation	Thickness of Insulation				Outer Covering	
Varnished Cambric	V	Varnished Cambric	14-8.....	3/64	Inch		Non-metallic covering or lead-sheath	
			6-2.....	4/64	Inch			
			1-4/0.....	5/64	Inch			
			213-500....	6/64	Inch			
			500-1000...	7/64	Inch			
			1001-2000..	8/64	Inch			
Asbestos & Varnished Cambric	AVA and AVL	Impregnated Asbestos & Varnished Cambric	(Dimen. in Mils)				AVA- asbestos braid or glass  AVL - lead sheath	
				AVA	AVL	2nd		2nd
				Asb	VC	Asb		Asb
			14-8 (solid only --	30	20	25		
			14-8	10	30	15		25
			6-2	15	30	20		25
			1-4/0	20	30	30		30
			213-500	25	40	40		40
			501-1000	30	40	40		40
			1001-2000	30	50	50		50
braided (switchboard wiring)				VC	Asb			
			18-8.....	30	20	Flame-retardant, cotton		
			6-2.....	40	30			
			1-4/0.....	40	40			
Asbestos & Varnished Cambric braid	AVB	Impregnated Asbestos & Varnished Cambric	14-8	Asb	VC	2nd Asb	Flame-retardant, cotton	
			6-2	15	30	20		
			1-4/0	20	30	30		
			213-500	25	40	40		
			501-1000-30	30	40	40		
			1001-2000-30	30	50	50		
Asbestos	A	Asbestos	14.....	30	Mils		Without asbestos braid	
			12-8.....	40	Mils			

The nonmetallic covering over individual rubber-covered conductors of aluminum sheathed cable and of lead-sheathed or multiple-conductor cable is not required to be flame retardant. For metal-clad cable, see Section 334-2. For nonmetallic-sheathed cable, see Section 336-2. For Type UF cable, see Section 339-1. For aluminum sheathed cable, see Section 331-9.

For insulated aluminum conductors, the minimum size is #12 AWG.  
See Tables 310-14 and 310-15.

Table 310-2(b). Conductor Insulations - Continued

Trade Name	Type Letter	Insulation	Thickness of Insulation		Outer Covering
Asbestos	AA	Asbestos	14.....	30 Mils	With asbestos braid or glass
			12-8.....	30 Mils	
			6-2.....	40 Mils	
			1-4/0.....	60 Mils	
Asbestos	AI	Impregnated Asbestos	14.....	30 Mils	Without Asbestos braid
			12-8.....	40 Mils	
Asbestos	AIA	Impregnated Asbestos	<b>Sol</b>		With asbestos braid or glass
			14	30 Mils	
			12-8	30 Mils	
			6-2	40 Mils	
			1-4/0-60	60 Mils	
			213-500	75 Mils	
		<b>Str</b>			
		501-1000	90 Mils		
			105 Mils		
Paper		Paper			Lead sheath

The nonmetallic covering over individual rubber-covered conductors of aluminum sheathed cable and of lead-sheathed or multiple-conductor cable is not required to be flame retardant. For metal-clad cable, see Section 334-2. For nonmetallic-sheathed cable, see Section 336-2. For Type UF cable, see Section 339-1. For aluminum sheathed cable, see Section 331-9.

For insulated aluminum conductors, the minimum size is #12 AWG. See Tables 310-14 and 310-15.

### 310-2. Insulating Materials.

(a) The rubber insulations include those made from natural and synthetic rubber, neoprene and other vulcanizable materials.

(b) Thermoplastic insulation may stiffen at temperatures below minus 10°C (14°F) and care should be used in its installation at such temperatures. It may be deformed when subject to pressure; care should be taken in its installation, as for example, at bushings, or points of support. See Section 373-6(b).

**310-4. Temperature Limitations.** No conductor shall be used under such conditions that its temperature, even when carrying current, will exceed the temperature specified in Table 310-2(a) for the type of insulation involved.

**310-5 Wet Locations.** Insulated conductors used underground, in concrete slabs or other masonry in direct contact with earth, in wet locations, or where condensation or accumulation of moisture within the raceway is likely to occur, shall be moisture- and heat-resistant, rubber-covered (Type RHW); moisture-resistant latex rubber (Type RUW); moisture-resistant, thermoplastic-covered (Type TW); moisture- and heat-resistant, thermoplastic-covered (Type THW); moisture- and heat-resistant thermoplastic (Type THWN); moisture- and heat-resistant cross-linked thermosetting polyethylene (Type XHHW); lead covered; aluminum sheathed cable (Type ALS); mineral insulated-metal sheathed (Type MI); or of a type approved for the purpose.

Such conductors are not suitable for direct burial in the earth unless of a type specifically approved for the purpose.

Table 310-2(i) (1)

Thickness of Rubber Insulation for Rubber-Covered Wire and Cable, in 64ths of an Inch

Conductor Size AWG or MCM	Classification				
	RH 10	RH 20	RHW 30†	RHW 40†	RHW 50†
14-12*	4	5	..	..	..
10- 8*	4	5	7	9	10*
6- 2	5	6	8	9	10
1-4/0	6	7	8	9	10
213-500	7	8	9	10	11
501-1000	8	9	9	10	11
1001-2000	9	9	10	11	12

\*No. 12 AWG is the minimum conductor size for aluminum and #8 AWG is the minimum conductor size for 5000 volts operation.

†Shall be of approved ozone-resistant type for operation at voltages over 2000.

Table 310-2(i) (2)

Thickness of Varnished-Cambric Insulation for  
Single-Conductor Cable, in 64ths of an Inch

Conductor Size AWG or MCM	For Voltages Not Exceeding				
	1000	2000	3000	4000	5000
14	4	..	..	..	..
12	4	5	..	..	..
10	4	5	6	..	..
8-2	4	5	6	7	9
1-4/0	5	6	6	7	9
213- 500	6	6	7	8	10
501-1000	7	7	7	8	10
1001-2000	8	8	8	9	10

Table 310-2(i) (3)

Thickness of Varnished-Cambric Insulation for  
Multiple-Conductor Cable, in 64ths of an Inch

Conductor Size AWG or MCM	For Voltages Not Exceeding									
	1000		2000		3000		4000		5000	
	C	B	C	B	C	B	C	B	C	B
14	4	0	..	..	..	..	..	..	..	..
12	4	0	5	0	..	..	..	..	..	..
10	4	0	5	0	5	2	..	..	..	..
8-2	4	0	5	0	5	2	6	3	6	4
1-4/0	5	0	6	0	6	2	6	3	6	4
213-500	6	0	6	0	6	2	6	3	7	4
501-1000	6	2	6	2	6	3	6	4	7	4
1001-2000	7	2	7	2	7	3	7	4	7	5

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

Table 310-2(i) (4)

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

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

**310-6. Buried Conductors.** Cables of one or more conductors for direct burial in the earth shall be of a type approved for the purpose and use, such as Types USE and UF. Where single conductor cables are installed, all conductors of each service, feeder, sub-feeder or branch circuit, including the neutral conductor, shall be run continuously in the same trench or raceway. Supplementary mechanical protection, such as a covering board, concrete pad, raceway, etc., may be required by the authority having jurisdiction. See Section 339-3(c).

**310-7. Corrosive Conditions.** Conductors exposed to oils, greases, vapors, gases, fumes, liquids or other substances having a deleterious effect upon the conductor or insulation shall be of a type approved for the purpose.

**310-8. Minimum Size of Conductors.** Conductors, whether solid or stranded, shall not be smaller than No. 14, except for printing press control circuits; as provided for flexible cords in Section 400-7; for fixture wire in Section 410-18; for fractional horsepower motors in Section 430-22; for cranes and hoists in Section 610-14; for elevator control and signal circuits in Section 620-12; and for remote-control, low energy power, low-voltage power and signal circuits in Section 725-13.

**310-9. Stranded Conductors.** Except when used as bus bars or in Type MI Cable, conductors No. 6 and larger, installed in raceways, shall be stranded.

**310-10. Conductors in Multiple.** Conductors in sizes 1/0 and larger may be run in multiple provided the arrangement is such as to assure equal division of total current among all conductors involved. All of the multiple conductors shall be of the same length, of the same conductor material, circular-mil area, same insulation type and terminated in the same manner. Where run in separate raceways or cables, the raceways or cables shall have the

same physical characteristics.

When conductors are used in multiple, space in enclosures should be given consideration.

**310-11. Ampacity Reduction Factors.** Where more than three conductors are installed in a raceway or assembled into one or more cables the ampacity of each conductor shall be reduced in accordance with Note 8 to Tables 310-12 through 310-15.

#### **Notes to Tables 310-12 through 310-15.**

**Ampacity.** The maximum, continuous, ampacities of copper conductors are given in Tables 310-12 and 310-13. The ampacities of aluminum conductors are given in Tables 310-14 and 310-15.

**1. Explanation of Tables.** For explanation of Type Letters, and for recognized size of conductors for the various conductor insulations, see Sections 310-2 and 310-3. For installation requirements, see Section 310-1 through 310-7, and the various Articles of this Code. For flexible cords see Tables 400-9 and 400-11.

**2. Application of Tables.** For open wiring on insulators and for concealed knob-and-tube work, the allowable ampacities of Tables 310-13 and 310-15 shall be used. For all other recognized wiring methods, the allowable ampacities of Tables 310-12 and 310-14 shall be used, unless otherwise provided in this Code.

**3. Aluminum Conductors.** For aluminum conductors, the allowable ampacities shall be in accordance with Tables 310-14 and 310-15.

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

**5. Type MI Cable.** The temperature limitation on which the ampacities of Type MI cable are based, is determined by the insulating materials used in the end seal. Termination fittings incorporating unimpregnated organic insulating materials are limited to 85°C. operation.

**6. Ultimate Insulation Temperature.** In no case shall conductors be associated together in such a way with respect to the kind of circuit, the wiring method employed, or the number of conductors, that the limiting temperature of the conductors will be exceeded.

**7. Use of Conductors with Higher Operating Temperatures.** Where the room temperature is within 10 degrees C of the maximum allowable operating temperature of the insulation, it is desirable to use an insulation with a higher maximum allowable operating temperature; although insulation can be used in a room temperature approaching its maximum allowable operating temperature limit if the current is reduced in accordance with the Correction Factors for different room temperatures as shown in the Correction Factor Table, Note 15.

**8. More than Three Conductors in a Raceway or Cable.** Tables 310-12 and 310-14 give the allowable ampacities for not more than three conductors in a raceway or cable. Where the number of conductors in a raceway or cable exceeds three, the allowable ampacity of each conductor shall be reduced as shown in the following Table:

Number of Conductors	Per Cent of Values in Tables 310-12 and 310-14
4 to 6	80
7 to 24	70
25 to 42	60
43 and above	50

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

Where the number of conductors in a raceway or cable exceeds three, or where single conductors or multi-conductor cables are stacked or bundled without maintaining spacing as required in Article 318 and are not installed in raceways, the individual ampacity of each conductor shall be reduced as shown in the above table.

Exception No. 2 - The derating factors of Section 210-23(b) and 220-2 (second paragraph) do not apply when the above derating factors are also required.

**9.** Where Type XHHW crosslinked thermosetting polyethylene insulated wire is used in wet locations, the allowable ampacities shall be that of Column 3 in Tables 310-12 through 310-15. Where used in dry locations, the allowable ampacities shall be that of Column 4 in Tables 310-12 through 310-15.

**10. Overcurrent Protection.** Where the standard ratings and settings of overcurrent devices do not correspond with the ratings and settings allowed for conductors, the next higher

standard rating and setting may be used.

Exception - Except as limited in Section 240-5.

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

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

Where the major portion of the load consists of electric discharge lighting there may be harmonic currents present in the neutral conductor which may be equal to the phase currents, thus the neutral could be considered to be a current-carrying conductor.

**12. Voltage Drop.** The allowable ampacities in Tables 310-12 through 310-15 are based on temperature alone and do not take voltage drop into consideration.

**13. Deterioration of Insulation.** It should be noted that even the best grades of rubber insulation will deteriorate in time, so eventually will need to be replaced.

**14. Aluminum Sheathed Cable.** The ampacities of Type ALS cable are determined by the temperature limitation of the insulated conductors incorporated within the cable. Hence the ampacities of aluminum sheathed cable may be determined from the columns in Tables 310-12 and 310-14 applicable to the type of insulated conductors employed within the cable. See Note 9.

15. Correction Factors.

Ambient Temps. Over 30°C. 86°F.

C.	F.	60°C (140°F)	75°C (167°F)	85°C (185°F)	90°C (194°F)	110°C (230°F)	125°C (257°)	200°C (392°F)
40	104	.82	.88	.90	.90	.94	.95	
.....								
45	113	.71	.82	.85	.85	.90	.92	
.....								
50	122	.58	.75	.80	.80	.87	.89	
.....								
55	131	.41	.67	.74	.74	.83	.86	
.....								
60	140	.....	.58	.67	.67	.79	.83	
.91								
70	158	.....	.35	.52	.52	.71	.76	
.87								
75	167	.....	.....	.43	.43	.66	.72	
.86								
80	176	.....	.....	.30	.30	.61	.69	
.84								
90	194	.....	.....	.....	.....	.50	.61	
.80								
100	212	.....	.....	.....	.....	.....	.51	
.77								
120	248	.....	.....	.....	.....	.....	.....	
.69								
140	284	.....	.....	.....	.....	.....	.....	
.59								

**Table 310-12. Allowable Ampacities of Insulated Copper Conductors**  
 Not More than Three Conductors in Raceway or Cable or  
 Direct Burial (Based on Ambient Temperature of 30°C. 86°F.)

Size		Temperature Rating of Conductor. See Table 310-2(a)					
AWG	60°C	75°C	85°C	90°C	110°C	125°C	200°C
MCM	(140°F)	(167°F)	(185°F)	(194°F)	(230°F)	(257°F)	(392°F)
	Types RUW (14-2),	Types RH, RHW,	Types V, MI	Types TA, TBS, SA,	Types AVA, AVL	Types AI (14-8),	Types A (14-
8)	T, TW	RUH (14-2), THW, THWN, XHHW, THW-MTW		AVB, SIS, FEP, FEPB, RHH, THHN, XHHW**		AIA	AA, FEP* FEPB*
14	15	15	25	25†	30	30	30
12	20	20	30	30†	35	40	40
10	30	30	40	40†	45	50	55
8	40	45	50	50	60	65	70
6	55	65	70	70	80	85	95
4	70	85	90	90	105	115	120
3	80	100	105	105	120	130	145
2	95	115	120	120	135	145	165
1	110	130	140	140	160	170	190
0	125	150	155	155	190	200	225
00	145	175	185	185	215	230	250
000	165	200	210	210	245	265	285
0000	195	230	235	235	275	310	340
250	215	255	270	270	315	335	....
300	240	285	300	300	345	380	....
350	260	310	325	325	390	420	....
400	280	335	360	360	420	450	....
500	320	380	405	405	470	500	....
600	355	420	455	455	525	545	....
700	385	460	490	490	560	600	....
750	400	475	500	500	580	620	....
800	410	490	515	515	600	640	....
900	435	520	555	555	....	....	....
1000	455	545	585	585	680	730	....
1250	495	590	645	645	....	....	....
1500	520	625	700	700	785	....	....
1750	545	650	735	735	....	....	....
2000	560	665	775	775	840	....	....

\*Special use only. See Table 310-2(a).

\*\*For dry locations only. See Table 310-2(a).

These ampacities relate only to conductors described in Table 310-2(a).

†The ampacities for Types FEP, FEPB, RHH, THHN, and XHHW conductors for sizes AWG 14, 12 and 10 shall be the same as designated for 75°C conductors in this Table.

For ambient temperatures over 30°C see Correction Factors Note 15.

**Table 310-13. Allowable Ampacities of Insulated Copper Conductors**  
 Single Conductor in Free Air  
 (Based on Ambient Temperature of 30°C. 86°F.)

Size	Temperature Rating of Conductor. See Table 310-2(a)							
AWG	60°C	75°C	85°C	90°C	110°C	125°C	200°C	
MCM	140°F	167°F	185°F	194°F	230°F	257°F	392°F	
	Types	Types	Types	Types	Types	Types	Types	Bare & Covered
	RUW	RH, RHW, RUH 14-2, T, TW	V, MI	TA, TBS, SA, AVB, SIS, FEP, FEPB, RHH, THHN, XHHW**	AVA, AVL	AI AIA	A AA, FEP* FEPB*	Conduc- tors
14	20	20	30	30†	40	40	45	30
12	25	25	40	40†	50	50	55	40
10	40	40	55	55†	65	70	75	55
8	55	65	70	70	85	90	100	70
6	80	95	100	100	120	125	135	100
4	105	125	135	135	160	170	180	130
3	120	145	155	155	180	195	210	150
2	140	170	180	180	210	225	240	175
1	165	195	210	210	245	265	280	205
0	195	230	245	245	285	305	325	235
00	225	265	285	285	330	355	370	275
000	260	310	330	330	385	410	430	320
0000	300	360	385	385	445	475	510	370
250	340	405	425	425	495	530	....	410
300	375	445	480	480	555	590	....	460
350	420	505	530	530	610	655	....	510
400	455	545	575	575	665	710	....	555
500	515	620	660	660	765	815	....	630
600	575	690	740	740	855	910	....	710
700	630	755	815	815	940	1005	....	780
750	655	785	845	845	980	1045	....	810
800	680	815	880	880	1020	1085	....	845
900	730	870	940	940	....	....	....	905
1000	780	935	1000	1000	1165	1240	....	965
1250	890	1065	1130	1130	....	....	....	....
1500	980	1175	1260	1260	1450	....	....	1215
1750	1070	1280	1370	1370	....	....	....	....
2000	1155	1385	1470	1470	1715	....	....	1405

\*Special use only. See Table 310-2(a).

\*\*For dry locations only. See Table 310-2(a).

These ampacities relate only to conductors described in Table 310-2(a).

†The ampacities for Types FEP, FEPB, RHH, THHN, and XHHW conductors for sizes AWG 14, 12 and 10 shall be the same as designated for 75°C conductors in this Table.

For ambient temperatures over 30°C, see Correction Factors Note 15.

**Table 310-14. Allowable Ampacities of Insulated Aluminum Conductors**

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

Size Temperature Rating of Conductor. See Table 310-2(a)							
AWG MCM	60°C (140°F)	75°C (167°F)	85°C (185°F)	90°C (194°F)	110°C (230°F)	125°C (257°F)	200°C (392°F)
	Types RUW (12-2), T, TW	Types RH, RHW, RUH (12-2), THW, THWN, XHHW,	Types V, MI	Types TA, TBS, SA, AVB, SIS, RHH, THHN, XHHW**	Types AVA, AVL	Types AI (12-8), AIA	Types A (12-8) AA
12	15	15	25	25†	25	30	30
10	25	25	30	30†	35	40	45
8	30	40	40	40†	45	50	55
6	40	50	55	55	60	65	75
4	55	65	70	70	80	90	95
3	65	75	80	80	95	100	115
*2	75	90	95	95	105	115	130
*1	85	100	110	110	125	135	150
*0	100	120	125	125	150	160	180
*00	115	135	145	145	170	180	200
*000	130	155	165	165	195	210	225
*0000	155	180	185	185	215	245	270
250	170	205	215	215	250	270	....
300	190	230	240	240	275	305	....
350	210	250	260	260	310	335	....
400	225	270	290	290	335	360	....
500	260	310	330	330	380	405	....
600	285	340	370	370	425	440	....
700	310	375	395	395	455	485	....
750	320	385	405	405	470	500	....
800	330	395	415	415	485	520	....
900	355	425	455	455	....	....	....
1000	375	445	480	480	560	600	....
1250	405	485	530	530	....	....	....
1500	435	520	580	580	650	....	....
1750	455	545	615	615	....	....	....
2000	470	560	650	650	705	....	....

These ampacities relate only to conductors described in Table 310-2(a).

\*For three wire, single phase service, the allowable ampacity of RH, RHH, RHW, and THW aluminum conductors shall be for sizes #2-100 Amp., #1-110 Amp., #1/0-125 Amp., #1/0-150 Amp., #3/0-170 Amp. and #4/0-200 Amp.

\*\*For dry locations only. See Table 310-2(a).

†The ampacities for Types RHH, THHN, and XHHW conductors for sizes AWG 12 and 10 shall be the same as designated for 75°C

conductors in this Table.

For ambient temperatures over 30°C, see Correction Factors Note 15.

**Table 310-15. Allowable Ampacities of Insulated Aluminum Conductors**

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

Size	Temperature Rating of Conductor. See Table 310-2(a)							
AWG	60°C	75°C	85°C	90°C	110°C	125°C	200°C	
MCM	140°F	167°F	185°F	194°F	230°F	257°F	392°F	
	Types RUW 12-2 T, TW	Types RH, RHW, RUH 12-2, THW, THWN XHHW	Types V, MI	Types TA, TBS, SA, AVB, SIS, RHH, THHN, XHHW*	Types AVA, AVL	Types AI 12-8 AIA	Types A 12-8 AA	Bare & Covered Conduc- tors
12	20	20	30	30†	40	40	45	30
10	30	30	45	45†	50	55	60	45
8	45	55	55	55	65	70	80	55
6	60	75	80	80	95	100	105	80
4	80	100	105	105	125	135	140	100
3	95	115	120	120	140	150	165	115
2	110	135	140	140	165	175	185	135
1	130	155	165	165	190	205	220	160
0	150	180	190	190	220	240	255	185
00	175	210	220	220	255	275	290	215
000	200	240	255	255	300	320	335	250
0000	230	280	300	300	345	370	400	290
250	265	315	330	330	385	415	....	320
300	290	350	375	375	435	460	....	360
350	330	395	415	415	475	510	....	400
400	355	425	450	450	520	555	....	435
500	405	485	515	515	595	635	....	490
600	455	545	585	585	675	720	....	560
700	500	595	645	645	745	795	....	615
750	515	620	670	670	775	825	....	640
800	535	645	695	695	805	855	....	670
900	580	700	750	750	....	....	....	725
1000	625	750	800	800	930	990	....	770
1250	710	855	905	905	....	....	....	....
1500	795	950	1020	1020	1175	....	....	985
1750	875	1050	1125	1125	....	....	....	....
2000	960	1150	1220	1220	1425	....	....	1165

These ampacities relate only to conductors described in Table 310-2(a).

\*For dry locations only. See Table 310-2(a).

†The ampacities for Types RHH, THHN, and XHHW conductors for sizes AWG 12 and 10 shall be the same as designated for 75°C conductors in this Table.

For ambient temperatures over 30°C, see Correction Factors Note 15.

**310-20 Simplified Wiring Table.** The Simplified Wiring Table, Table 310-21, may be used for the selection of feeder and branch circuit conductor sizes and insulation types only under the conditions stated in this Section. The Simplified Wiring Table shall be used only when a demand factor of 80% or less exists.

**(a) Application of Table 310-21.**

- (1) Determine load amperes, either continuous or noncontinuous. [Sec. 310-20(b).]
- (2) Select conductor sizes from Table 310-21.
- (3) Determine ambient temperature. Use 30°C (86°F) except where higher ambients may be expected as covered in Section 310-20(c).
- (4) Select wire insulation type from Table 310-20(c) and Section 310-2(a).

**Table 310-20(c). Typical Ambient Temperatures**

Location	Temperature	Minimum Rating of Required Conductor Insulation
Well ventilated, normally heated buildings	30°C (86°F)	*(See note below)
Buildings with such major heat sources as power stations or industrial processes	40°C (104°F)	75°C (167°F)
Poorly ventilated spaces such as attics	45°C (113°F)	
Furnaces and boiler rooms (min.)	40°C (104°F)	
(max.)	60°C (140°F)	75°C (167°F) 90°C (194°F)
Outdoors in shade in air	40°C (104°F)	75°C (167°F)
In thermal insulation	45°C (113°F)	75°C (167°F)
Direct solar exposure	45°C (113°F)	110°C (230°F)
Places above 60°C (140°F)		

\*Note: 60°C for up to & including #8 AWG copper & up to & including

#6 AWG aluminum. 75°C for over #8 AWG copper & #6 AWG aluminum.

(b) Loads.

(1) **Continuous.** Continuous loads are expected to continue for three hours or longer [see Section 210-23(b).]

(2) **Noncontinuous.** Loads are noncontinuous where 67 per cent or less of the load is expected to be continuous.

**Table 310-21. Simplified Wiring Table**  
 (See Section 310-20 for use)  
**Conductor Size\* - 6 or Fewer Conductors in Raceway or Cable**

Amp.	Copper				Aluminum			
	Non-Cont.		Continuous		Non-Cont.		Continuous	
	AWG	MCM	AWG	MCM	AWG	MCM	AWG	MCM
15	14		14		12		12	
20	12		12		10		10	
25	10		10		8		8	
30	10		10		8		8	
35	8		8		6		6	
40	8		8		6		6	
45	6		6		4		4	
50	6		6		4		4	
60	4		4		4		4	
70	4		4		3		3	
80	3		3		3		2	
90	3		2		2		1	
100	2		1		1		0	
110	1		0		0		2/0	
125	1		0		2/0		3/0	
150	0		2/0		3/0		4/0	
175	2/0		3/0		4/0			250
200	3/0		4/0			250		300
225	4/0			250		300		350
250		250		300		350		400
300		350		400		400		750
350		400		500		500		1000
400		500		750		750		
450		750		1000		1000		
500		750				1000		
600		1000						

\*Neutral conductors shall be treated in accordance with Note 11 -Neutral Conductors of Notes to Tables 310-12 through 310-15.

(c) **Ambient Temperature.** Ambient temperature is the temperature of the medium, such as air, water or earth, into which the heat of the conductor is dissipated. Ambient temperatures vary and values typical of the installation condition shall be used for determining the type of conductor insulation when applying the Simplified Wiring Table. See Table 310-20(c).

(d) **Conductors in Air.** For ampacities of single conductors in air, use Tables 310-13 and 310-15.

**310-21. Conductor Ampacity.** In Table 310-21 the values of amperes apply to actual diversified continuous or noncontinuous connected loads. This Table shall not be used to determine conductor ampacity; use Tables 310-12 to 310-15 for this purpose.