

Chapter E 310

CONDUCTORS FOR GENERAL WIRING

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**E 310.01 General.** (1) The purpose of this chapter is to assure that conductors have mechanical strength, insulation, and ampacity adequate for the particular conditions under which they are to be used.

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

(3) The provisions of this chapter 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.

**History:** Cr. Register, January, 1968, No. 145, eff. 2-1-68.

**E 310.02 Application and construction.** (1) CONDUCTOR APPLICATION. Conductor insulations as specified in the following table E 310.02 (1) may be installed for any of the wiring methods recognized herein, except as otherwise provided for in the table or in section E 310.03, or as otherwise specified in this code. They are suitable for 600 volts unless otherwise specified.

(2) CONDUCTOR CONSTRUCTION. Insulated conductors for use at 600 volts or less shall conform to the provisions of table E 310.02 (2).

TABLE E 310.02 (1)  
CONDUCTOR APPLICATION

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions
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 E 310.08.
Rubber-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 E 310.08.
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 E 310.08.

\*Fixture wires are not intended for installation as branch circuit conductors nor for the connection of portable or stationary appliances.

TABLE E 310.02 (1)—Continued

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions
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 E 310.08.
Thermoplastic Covered Fixture Wire—Solid or Stranded	*TF	60°C 140°F	Fixture wiring, and as permitted in section E 310.08, and for circuits as permitted in Chapter E 725.
Thermoplastic-Covered Fixture Wire—Flexible Stranding	*TFF	60°C 140°F	Fixture wiring, and as permitted in section E 310.08, and for circuits as permitted in Chapter E 725.
Fluorinated Ethylene Propylene	*PF	200°C 392°F	Fixture wiring, and as permitted in section E 310.08.
Fixture Wire, Solid or 7-Strand	*PGF	200°C 392°F	Fixture wiring, and as permitted in section E 310.08.
Fluorinated Ethylene Propylene	*PFF	150°C 302°F	Fixture wiring, and as permitted in section E 310.08.
Fixture Wire, Flexible Stranding	*PGFF	150°C 302°F	Fixture wiring, and as permitted in section E 310.08.
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 300 V. and Indoor Dry Location.
Silicone Rubber Insulated Fixture Wire	*SF-1	200°C 392°F	Fixture wiring. Limited to 300 V.
Solid or 7-Strand	*SF-2	200°C 392°F	Fixture wiring, and as permitted in E 310.08.
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 E 310.08.
Code Rubber	R	60°C 140°F	Dry Locations.
Heat-Resistant Rubber	RH	75°C 167°F	Dry Locations.
Heat-Resistant Rubber	RHH	90°C 194°F	Dry Locations.
Moisture-Resistant Rubber	RW	60°C 140°F	Dry and wet locations. For over 2000 volts, insulation shall be ozone-resistant.
Moisture and Heat-Resistant Rubber	RH-RW	60°C 140°F 75°C 167°F	Dry and wet locations. For over 2000 volts, insulation shall be ozone-resistant. Dry locations. For over 2000 volts, insulation shall be ozone-resistant.
Moisture and Heat-Resistant Rubber	RHW	75°C 167°F	Dry and wet locations. For over 2000 volts, insulation shall be ozone-resistant.
Latex Rubber	RU	60°C 140°F	Dry locations.

\*Fixture wires are not intended for installation as branch circuit conductors nor for the connection of portable or stationary appliances.

TABLE E 310.02 (1)—Continued

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions
Heat-Resistant Latex Rubber	RUH	75°C	Dry locations.
Moisture-Resistant Latex Rubber	RUW	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.
Mineral Insulation (Metal Sheathed)	MI	85°C 185°F  250°C 482°F	Dry and wet locations with Type O termination fittings.  For special application.
Thermoplastic and Asbestos	TA	90°C 194°F	Switchboard wiring only.
Silicone-Asbestos	SA	90°C 194°F	Dry locations — max. operating temperature for special applications 125°C.
Thermoplastic and Fibrous Outer Braid	TBS	90°C 194°F	Switchboard wiring only.
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 230°F	Dry and wet locations.
Asbestos and Varnished Cambric	AVB	90°C 194°F	Dry locations only.
Synthetic Heat Resistant	SIS	90°C 194°F	Switchboard wiring only.
Fluorinated Ethylene Propylene	FEP or FEPB	90°C 194°F  200°C 392°F	Dry locations.  Dry locations—special applications.
Asbestos	A	200°C 392°F	Dry locations only. In raceways, only for leads to or within apparatus. Limited to 300 V.
Asbestos	AA	200°C 392°F	Dry locations only. Open wiring. In raceways, only for leads to or within apparatus. Limited to 300 V.
Asbestos	AI	125°C 267°F	Dry locations only. In raceways, only for leads to or within apparatus. Limited to 300 V.
Asbestos	ATA	125°C 267°F	Dry locations only. Open wiring. In raceways, only for leads to or within apparatus.
Paper		95°C 185°F	For underground service conductors, or by special permission.

**TABLE E 310.02 (2)**  
**CONDUCTOR INSULATIONS**

Trade Name	Type Letter	Insulation	Thickness of Insulation	Outer Covering
Heat-Resistant Latex Rubber	RUH	90% Unmilled, Grainless Rubber	14-10.....18 Mils 8-2.....25 Mils	Moisture-resistant, flame-retardant, non-metallic covering
Moisture-Resistant Latex Rubber	RUW	90% Unmilled, Grainless Rubber	14-10.....18 Mils 8-2.....25 Mils	Moisture-resistant, flame-retardant, non-metallic covering
Thermoplastic	T	Flame Retardant, Thermoplastic Compound	14-10.....2/64 Inch 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	None
Moisture-Resistant Thermoplastic	TW	Flame-Retardant, Moisture-Resistant Thermoplastic	14-10.....2/64 Inch 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	None
Moisture and Heat-Resistant Thermoplastic	THW	Flame-Retardant, Moisture and Heat-Resistant Thermoplastic	14-10.....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	None
Moisture and Heat-Resistant Thermoplastic	THWN	Flame-Retardant, Moisture and Heat-Resistant Thermoplastic	14-12.....15 Mils 10.....20 Mils 8-6.....30 Mils 4-2.....40 Mils 1-4/0.....50 Mils 250-500 MCM.....60 Mils	Nylon Jacket
Thermoplastic and Asbestos	TA	Thermoplastic and Asbestos	Th'pl'. Asb. 14-8.....20 Mils 20 Mils 6-2.....30 Mils 25 Mils 1-4/0.....40 Mils 30 Mils	Flame-retardant, non-metallic covering

TABLE E 310.02 (2)—Continued

Trade Name	Type Letter	Insulation	Thickness of Insulation	Outer Covering
Heat-Resistant Thermoplastic	THHN	Flame-Retardant Heat-Resistant Thermoplastic	14-12.....15 Mils	Nylon Jacket
			10.....20 Mils	
			8-6.....30 Mils	
			4-2.....40 Mils	
			1-4/0.....50 Mils	
250-500 MCM.....60 Mils				
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				
Thermoplastic and Fibrous Braid	TBS	Thermoplastic	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 Mils	
Fluorinated Ethylene Propylene	FEP	Fluorinated Ethylene Propylene	14-10.....20 Mils	None
			8-2.....30 Mils	
	FEPB	Fluorinated Ethylene Propylene	14-8.....14 Mils	Glass braid
			6-2.....14 Mils	Asbestos braid
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	
			501-1000.....7/64 Inch	
			1001-2000.....8/64 Inch	

Note: The non-metallic 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 E 334.04. For non-metallic-sheathed cable, see section E 336.02. For type UF cable, see section E 339.01. For aluminum sheathed cable, see section E 331.09.

TABLE E 310.02 (2)—Continued

Trade Name	Type Letter	Insulation	Thickness of Insulation				Outer Covering		
			(Dimen. in Mils)						
			1st Asb.	VC	AVA 2nd Asb.	AVL 2nd Asb.			
Asbestos and Varnished Cambric	AVA and AVL	Impregnated Asbestos and Varnished Cambric	14-8 (solid only)-----	30	20	25	AVA—asbestos braid or glass AVL—lead sheath		
			14-8-----	10	30	15			
			6-2-----	15	30	20			
			1-4/0-----	20	30	30			
			213-500-----	25	40	40			
			501-1000-----	30	40	40			
			1001-2000-----	30	50	50			
								VC	Asb.
Asbestos and Varnished Cambric	AVB	Impregnated Asbestos and Varnished Cambric	18-8-----		30	20	Flame-retardant, cotton braid (switchboard wiring)		
			6-2-----		40	30			
			1-4/0-----		40	40			
						Asb.	VC	2nd Asb.	Flame-retardant, cotton braid
			14-8-----	10	30	15			
			6-2-----	15	30	20			
			1-4/0-----	20	30	30			
			213-500-----	25	40	40			
501-1000-----	30	40	40						
1001-2000-----	30	50	50						
Asbestos	A	Asbestos	14-----		30	Mils	Without asbestos braid		
			12-8-----		40	Mils			
Asbestos	AA	Asbestos	14-----		30	Mils	With asbestos braid or glass		
			12-8-----		30	Mils			
			6-2-----		40	Mils			
			1-4/0-----		60	Mils			
Code	R	Code Rubber	14-12-----		2/64	Inch	*Moisture-resistant, flame-retardant, non-metallic covering		
			10-----		3/64	Inch			
			8-2-----		4/64	Inch			
			1-4/0-----		5/64	Inch			
			213-500-----		6/64	Inch			

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

TABLE E 310.02 (2)—Continued

Trade Name	Type Letter	Insulation	Thickness of Insulation	Outer Covering
			501-1000.....7/64 Inch 1001-2000.....8/64 Inch	
Heat-Resistant	RH RHH	Heat-Resistant Rubber	**14-12.....2/64 Inch 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-resistant, flame-retardant, non-metallic covering
Moisture-Resistant	RW	Moisture-Resistant Rubber	14-10.....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-resistant, flame-retardant, non-metallic covering
Moisture and Heat Resistant	RH-RW RHW	Moisture and Heat Resistant Rubber	14-10.....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-resistant, flame-retardant, non-metallic covering
Asbestos	AI	Impregnated Asbestos	14.....30 Mils 12-8.....40 Mils	Without asbestos braid
Asbestos	AIA	Impregnated Asbestos	14.....Sol. 30 Mils Str. 30 Mils 12-8.....30 Mils 40 Mils 6-2.....40 Mils 60 Mils 1-4/0.....60 Mils 75 Mils 213-500.....90 Mils 501-1000.....105 Mils	With asbestos braid or glass
Paper		Paper		Lead sheath

\*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.

(3) **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:

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

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

(c) Name of the manufacturing company, and, if desired, trade name of the wire.

(d) Month and year when manufactured.

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

(4) **SURFACE MARKING.** (a) A durable marking on the surface shall be provided at intervals not exceeding 24 inches showing the name of the manufacturer or a significant abbreviation thereof, type letter or letters as specified in chapter E 810, table E 810.02 (2) and chapters E 836, E 838 and E839, 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 conductors only, rubber insulated and thermoplastic insulated for general wiring.

2. Nonmetallic sheathed cable.

3. Service-entrance cable.

4. Underground feeder and branch circuit cable.

(b) 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.

(5) **CLASSIFICATION.** In addition to the type letters specified in table E 810.02 (2), the following letters shall apply:

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

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

(c) The letter "M" used as a suffix indicates an assembly of 2 or more insulated conductors twisted together under an outer non-metallic covering.

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

(e) *Voltage.* Type letters, when used alone, indicate conductors for use at not more than 600 volts. Conductors for use at higher volt-

ages 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.

*Note:* The working voltages referred to in the table are the operating voltages between phases of single and 2-phase systems, and 3-phase systems with grounded or ungrounded neutral.

(f) All NEC standard conductors shall be examined and tested at the factory and, if approved, shall be labeled before shipment.

(6) IDENTIFICATION OF INSULATION. All rubber-insulated conductors and all thermoplastic-insulated conductors, No. 14 and larger, shall have a readily recognizable durable marking to indicate the grade of insulation; except that single-conductor, code-rubber insulated conductors having a lead sheath; and multi-conductor cables, armored cable, and non-metallic-sheathed cable having code-rubber or non-moisture-resistant thermoplastic-insulated conductors, need not be so marked.

(7) IDENTIFIED CONDUCTORS. (a) 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.

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

2. Exception No. 2. Fixture wire as outlined below.

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

(b) For fixture wires the identification shall be as above, or by means of stripes or by the means described in sections E 400.13 (1), (2), (3), (4) and (5).

*Note:* 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.

(8) 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 E200.06 (2).

(9) INSULATION THICKNESS; OVER 600 VOLTS. The thickness of insulation for conductors for use at over 600 volts shall conform to tables E 310.02 (9) (a) through E 310.02 (9) (d):

TABLE E 310.02 (9) (a)

## THICKNESS OF RUBBER INSULATION FOR RUBBER-COVERED WIRE AND CABLE, IN 64THS OF AN INCH

Conductor Size AWG or MCM	Classification				
	R 10 RH 10 RW 10 RHW 10	R 20 RH 20 RW 20 RHW 20	RW 30** RH-RW 30** RHW 30**	RW 40** RH-RW 40** RHW 40**	RW 50** RH-RW 50** 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. 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 E 310.02 (9) (b)

## 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 E 310.02 (9) (c)

## 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	5	2	-----	-----	-----	-----
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	0	6	2	6	3	6	4	7	4
1001-2000-----	7	2	7	2	7	3	7	4	7	5

Note: 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 E 310.02 (9) (d)

**THICKNESS OF ASBESTOS AND VARNISHED-CAMBRIC INSULATION FOR SINGLE-CONDUCTOR CABLE, TYPES AVA, AVB AND AVL, IN MILS**

Conductor Size AWG or MCM	1st Wall Asbestos	Varnished Cambric					2nd Wall Asbestos
	For Voltages Not Exceeding						
	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

**History:** Cr. Register, January, 1968, No. 145, eff. 2-1-68.

**E 310.03 Insulating materials.** (1) The rubber insulations include those made from natural and synthetic rubber, neoprene and other vulcanizable materials.

(2) 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 Wis. Adm. Code section E 373.06 (2).

**History:** Cr. Register, January, 1968, No. 145, eff. 2-1-68.

**E 310.04 Temperature limitations.** No conductor shall be used under such conditions that its temperature, even when carrying current, will exceed the temperature specified in table E 310.02 (1) for the type of insulation involved.

**History:** Cr. Register, January, 1968, No. 145, eff. 2-1-68.

**E 310.05 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-resistant, rubber-covered (type RW); moisture-and heat-resistant (type RH-RW); 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); lead covered; aluminum sheathed cable (type ALS); mineral insulated-metal sheathed (type MI); or of a type approved for the purpose.

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

**History:** Cr. Register, January, 1968, No. 145, eff. 2-1-68.

**E 310.06 Buried conductors.** Cables of one or more conductors for direct burial in the earth shall be type USE, except that branch circuit and feeder cable may be type 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 pro-

tection, such as a covering board, concrete pad, raceway, etc., may be required by the administrative authority. See section E 339.03 (3).

**History:** Cr. Register, January, 1968, No. 145, eff. 2-1-68.

**E 310.07 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.

**History:** Cr. Register, January, 1968, No. 145, eff. 2-1-68.

**E 310.08 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 E 400.07; for fixture wire in section E 410.18; for fractional horsepower motors in section E 430.022; for cranes and hoists in section E 610.14; and for remote-control, low-energy power, low voltage power and signal circuits in section E 725.13.

**History:** Cr. Register, January, 1968, No. 145, eff. 2-1-68.

**E 310.09 Stranded conductors.** Except when used as bus bars or in type MI cable, conductors No. 6 and larger, installed in raceways shall be stranded.

**History:** Cr. Register, January, 1968, No. 145, eff. 2-1-68.

**E 310.10 Conductors in multiple.** Conductors in sizes smaller than 1/0 shall not be run in multiple. Conductors in size 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.

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

**History:** Cr. Register, January, 1968, No. 145, eff. 2-1-68.

**E 310.11 Ampacity reduction factors.** Where more than 3 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 E 310.12 through E 310.15.

*Note:* The maximum continuous ampacities of copper conductors are given in table E 310.12 and E 310.13. The ampacities of aluminum conductors are given in tables E 310.14 and E 310.15.

**History:** Cr. Register, January, 1968, No. 145, eff. 2-1-68.

#### Notes to Tables E 310.12 through E 310.15

1. *Explanation of tables.* For explanation of type letters, and for recognized size of conductors for the various conductor insulations, see sections E 310.02 and E 310.03. For installation requirements, see sections E 310.01 through E 310.07, and the various chapters of this code. For flexible cords see tables E 400.09 and E 400.11.

2. *Application of tables.* For open wiring on insulators and for concealed knob-and-tube work, the allowable ampacities of tables E 310.13 and E 310.15 shall be used. For all other recognized wiring methods, the allowable ampacities of tables E 310.12 and E 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 E 310.14 and E 310.15.

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

5. *Type MI cable.* The temperature limitation on which the current-carrying capacities 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° 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.

8. *More than 3 conductors in a raceway or cable.* Tables E 310.12 and E 310.14 give the allowable ampacities for not more than 3 conductors in a raceway, or cable. Where the number of conductors in a raceway or cable exceeds 3, the allowable ampacity of each conductor shall be reduced as shown in the following table:

Number of Conductors	Per Cent of Values in Tables E 310.12 and E 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 E 300.03 are installed in a common raceway the derating factors shown above apply to the number of Power and Lighting (chapters E 210, E 215, E 220 and E 230) conductors only.

Exception No. 2. The derating factors of sections E 210. 23 (2) and E 220.02 (2) do not apply when the above derating factors are also required.

Exception No. 3. The derating factors shown above do not apply to branch circuits supplying an individual residential occupancy.

a. Where the number of conductors in a raceway or cable exceeds 3, or where single conductors or multi-conductor cables are stacked or bundled without maintaining spacing as required in chapter E 318 and are not installed in raceways, the individual ampacity of each conductor shall be reduced as shown in the above table.

9. *Use of type RH-RW rubber insulated wire.* Where type RH-RW rubber insulated wire is used in wet locations the allowable ampacities shall be those of column 2 in tables E 310.12 through E 310.15. Where used in dry locations the allowable ampacities shall be those of column 3 in tables E 310.12 through E 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 except as limited in section E 240.05.

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

a. In a 3-wire circuit consisting of 2 phase wires and the neutral of a 4-wire, 3 phase WYE connected system, a common conductor carries approximately the same current as the other conductors and is not therefore considered as a neutral conductor.

12. *Voltage drop.* The allowable ampacities in tables E 310.12 through E 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 cables 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 E 310.12 and E 310.14 applicable to the type of insulated conductors employed within the cable. See note 9.

TABLE E 310.12

ALLOWABLE AMPACITIES OF INSULATED COPPER CONDUCTORS

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

Size AWG MCM	Temperature Rating of Conductor. See Table B 310.02 (1)					
	60°C (140°F)	75°C (167°F)	85-90°C (185°F)	110°C (230°F)	125°C (257°F)	200°C (392°F)
14	15	15	25*	30	30	30
12	20	20	30*	35	40	40
10	30	30	40*	45	50	55
8	40	45	50	60	65	70
6	55	65	70	80	85	95
4	70	85	90	105	115	120
3	80	100	105	120	130	145
2	95	115	120	135	145	165
1	110	130	140	160	170	190
0	125	150	155	190	200	225
00	145	175	185	215	230	250
000	165	200	210	245	265	285
0000	195	230	235	275	310	340
250	215	255	270	315	335	-----
300	240	285	300	345	380	-----
350	260	310	325	390	420	-----
400	230	335	360	420	450	-----
500	320	380	405	470	500	-----
600	355	420	455	525	545	-----
700	335	460	490	560	600	-----
750	400	475	500	530	620	-----
800	410	490	515	600	640	-----
900	435	520	555	-----	-----	-----
1000	455	545	585	680	730	-----
1250	495	590	645	-----	-----	-----
1500	520	625	700	785	-----	-----
1750	545	650	735	-----	-----	-----
2000	560	665	775	840	-----	-----

CORRECTION FACTORS, ROOM TEMPERATURES OVER 30°C. 86°F.

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

These ampacities relate only to conductors described in table E 310.02 (1).

\*The ampacities for types FEP, FEPB, RHH, and THHN conductors for sizes AWG 14, 12 and 10 shall be the same as designated for 75°C conductors in this table.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

**TABLE E 310.13**  
**ALLOWABLE AMPACITIES OF INSULATED COPPER CONDUCTORS**

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

Size AWG	Temperature Rating of Conductor. See Table E 310.02 (1)						Bare and Covered Conductor
	60°C (140°F)	75°C (167°F)	85-90°C (185°F)	110°C (230°F)	125°C (257°F)	200°C (392°F)	
14	20	20	30*	40	40	45	30
12	25	25	40*	50	50	55	40
10	40	40	55*	65	70	75	55
8	55	65	70	85	90	100	70
6	80	95	100	120	125	135	100
4	105	125	135	160	170	180	130
3	120	145	155	180	195	210	150
2	140	170	180	210	225	240	175
1	165	195	210	245	265	280	205
0	195	230	245	285	305	325	235
00	225	265	285	330	355	370	275
000	260	310	330	385	410	430	320
0000	300	360	385	445	475	510	370
250	340	405	425	495	530	-----	410
300	375	445	480	555	590	-----	460
350	420	505	530	610	655	-----	510
400	455	545	575	665	710	-----	555
500	515	620	660	765	815	-----	630
600	575	690	740	855	910	-----	710
700	630	755	815	940	1005	-----	780
750	655	785	845	980	1045	-----	810
800	680	815	880	1020	1085	-----	845
900	730	870	940	-----	-----	-----	-----
1000	780	935	1000	1165	1240	-----	965
1250	890	1065	1130	-----	-----	-----	-----
1500	980	1175	1260	1450	-----	-----	1215
1750	1070	1280	1370	-----	-----	-----	-----
2000	1155	1385	1470	1715	-----	-----	1405

**CORRECTION FACTORS, ROOM TEMPERATURES OVER 30°C. 86°F.**

C. F.							
40 104	.82	.88	.90	.94	.95	-----	-----
45 113	.71	.82	.85	.90	.92	-----	-----
50 122	.58	.75	.80	.87	.89	-----	-----
55 131	.41	.67	.74	.83	.86	-----	-----
60 140	-----	.58	.67	.79	.83	.91	-----
70 153	-----	.35	.52	.71	.76	.87	-----
75 167	-----	-----	.43	.66	.72	.85	-----
80 176	-----	-----	.30	.61	.69	.84	-----
90 194	-----	-----	-----	.50	.61	.80	-----
100 212	-----	-----	-----	-----	.61	.77	-----
120 240	-----	-----	-----	-----	-----	.69	-----
140 284	-----	-----	-----	-----	-----	.69	-----

These ampacities relate only to conductors described in table E 310.02 (1).

\*The ampacities for types FEP, FEPB, RHH and THHN conductors for size AWG 14 and 12 shall be the same as designated for 75°C conductors in this table.

**History:** Cr. Register, January, 1968, No. 145, eff. 2-1-68.

**TABLE E 310.14**  
**ALLOWABLE AMPACITIES OF INSULATED ALUMINUM**  
**CONDUCTORS**

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

Size AWG MCM	Temperature Rating of Conductor. See Table E 310.02 (1)					
	60°C (140°F)	75°C (167°F)	85-90°C (185°F)	110°C (230°F)	125°C (257°F)	200°C (392°F)
12	15	15	25**	25	30	30
10	25	25	30**	35	40	45
8	30	40	40**	45	50	55
6	40	50	55	60	65	75
4	55	65	70	80	90	95
3	65	75	80	95	100	115
*2	75	90	95	105	115	130
*1	85	100	110	125	135	150
*0	100	120	125	150	160	180
*00	115	135	145	170	180	200
*000	130	155	165	195	210	225
*0000	155	180	185	215	245	270
250	170	205	215	250	270	-----
300	190	230	240	275	305	-----
350	210	250	260	310	335	-----
400	225	270	290	335	360	-----
500	260	310	330	380	405	-----
600	285	340	370	425	440	-----
700	310	375	395	455	485	-----
750	320	385	405	470	500	-----
800	330	395	415	485	520	-----
900	355	425	455	-----	-----	-----
1000	375	445	480	560	600	-----
1250	405	485	530	-----	-----	-----
1500	435	520	580	650	-----	-----
1750	455	545	615	-----	-----	-----
2000	470	560	650	705	-----	-----
<b>CORRECTION FACTORS, ROOM TEMPERATURES OVER 30°C. 86°F.</b>						
C.	F.					
40	104	.82	.88	.90	.94	.95
45	113	.71	.82	.85	.90	.92
50	122	.58	.75	.80	.87	.89
55	131	.41	.67	.74	.83	.86
60	140	-----	.58	.67	.79	.83
70	158	-----	.35	.52	.71	.76
75	167	-----	-----	.43	.66	.72
80	176	-----	-----	.30	.61	.69
90	194	-----	-----	-----	.50	.61
100	212	-----	-----	-----	-----	.51
120	248	-----	-----	-----	-----	.69
140	284	-----	-----	-----	-----	.59

These ampacities relate only to conductors described in table E 310.02 (1). For three wire, single phase service and sub-service circuits, the allowable ampacity of RH, RH-RW, RHH, RHW, and THW aluminum conductors shall be for sizes #2-100 Amp., #1-110 Amp., #1/0-125 Amp., #2/0-150 Amp., #3/0-170 Amp. and #4/0-200 Amp.

\*The ampacities for types RHH and THHN conductors for sizes AWG 12, 10 and 8 shall be the same as designated for 75°C conductors in this table.

**History:** Cr. Register, January, 1968, No. 145, eff. 2-1-68.

**TABLE E 310.15**  
**ALLOWABLE AMPACITIES OF INSULATED ALUMINUM CONDUCTORS**

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

Size AWG MCM	Temperature Rating of Conductor. See Table E 310.02 (1)						Bare and Covered Conductor
	60°C (140°F)	75°C (167°F)	85°-90°C (185°F)	110°C (230°F)	125°C (257°F)	200°C (392°F)	
12	20	20	30*	40	40	45	30
10	30	30	45*	50	55	60	45
8	45	55	55*	65	70	80	55
6	60	75	80	95	100	105	80
4	80	100	105	125	135	140	100
3	95	115	120	140	150	165	115
2	110	135	140	165	175	185	135
1	130	155	165	190	205	220	160
0	160	180	190	220	240	255	185
00	175	210	220	255	275	290	215
000	200	240	255	300	320	335	250
0000	230	280	300	345	370	400	290
250	265	315	330	385	415	-----	320
300	290	350	375	435	460	-----	360
350	330	395	415	475	510	-----	400
400	365	425	450	520	555	-----	435
500	405	485	515	595	635	-----	490
600	455	545	585	675	720	-----	560
700	500	595	645	745	795	-----	615
750	515	620	670	775	825	-----	640
800	535	645	695	805	855	-----	670
900	580	700	750	-----	-----	-----	725
1000	625	750	800	980	990	-----	770
1250	710	855	905	-----	-----	-----	-----
1500	795	950	1020	1175	-----	-----	985
1750	875	1050	1125	-----	-----	-----	-----
2000	960	1150	1220	1425	-----	-----	1165

**CORRECTION FACTORS, ROOM TEMPERATURES OVER 30°C. 86°F.**

C. F.							
40 104	.82	.88	.90	.94	.95	-----	-----
45 113	.71	.82	.85	.90	.92	-----	-----
50 122	.58	.75	.80	.87	.89	-----	-----
55 131	.41	.67	.74	.83	.86	-----	-----
60 140	-----	.58	.67	.79	.83	.91	-----
70 153	-----	.35	.52	.71	.76	.87	-----
75 167	-----	-----	.43	.66	.72	.86	-----
80 176	-----	-----	.30	.61	.69	.84	-----
90 194	-----	-----	-----	.50	.61	.80	-----
100 212	-----	-----	-----	-----	.51	.77	-----
120 243	-----	-----	-----	-----	-----	.69	-----
140 284	-----	-----	-----	-----	-----	.59	-----

\*These ampacities relate only to conductors described in table E 310.02 (1).

\*The ampacities for types RHH and THHN conductors for sizes AWG 12, 10 and 8 shall be the same as designated for 75°C conductors in this table.

**History:** Cr. Register, January, 1968, No. 145, eff. 2-1-68.