

WIRING METHODS AND MATERIALS

CHAPTER E-300

WIRING METHODS - GENERAL REQUIREMENTS

E-300.01. Scope.

(1) The provisions herein apply to the electrical and mechanical requirements for the various methods of installing fixed electrical conductors for electric light, heat and power and certain signal systems.

(2) The provisions of this Chapter shall apply to all wiring installations, except for remote-control, including low voltage relay switching, low-energy power and signal systems as provided in Chapter E-725, and communication systems as provided in Chapter E-800.

(3) On premises where a continuous underground metallic waterpiping network system is not available as a grounding electrode, and where it is not practicable otherwise to secure a ground of permanently low resistance, the use of a wiring method which does not employ metal enclosures for the wires is recommended, unless the character or occupancy of the building is such as to require the use of a metal-enclosed wiring system.

(4) The provisions of this Chapter are not intended to apply to the conductors which form an integral part of equipment such as motors, motor controllers and the like.

E-300.02. Voltage Limitations.

Wiring methods specified herein may be used for voltages not exceeding 600, unless specifically limited in some chapter. They may be used for voltages over 600 where specifically permitted elsewhere in this code.

E-300.03. Conductors of Different Systems.

(1) Conductors of light and power systems of 600 volts or less may occupy the

same enclosure, without regard to whether the individual circuits are alternating-current or direct-current, only where all conductors are insulated for the maximum voltage of any conductor within the enclosure.

(a) Where A.C. and D.C. lighting or power conductors occupy the same enclosure, the D.C. conductors shall be marked "D.C." at all places of access.

(2) Conductors of light and power systems of over 600 volts shall not occupy the same enclosure with conductors of light and power systems of 600 volts or less.

(3) Secondary wiring to electric discharge lamps of 1,000 volts or less may occupy the same enclosure as the branch circuit conductors.

(4) Control, relay and ammeter conductors used in connection with any motor or starter may occupy the same enclosure as the motor circuit conductors.

(5) Conductors of signal or radio systems shall not occupy the same enclosure with conductors of light or power systems except as permitted for elevators in E-620.36; for sound recording in E-640.05; for remote-control, low-energy power and signal circuits in E-725.16 and E-725.42; and communication system in E-800.02 and E-800.21.

E-300.04. Protection Against Physical Damage.

Where subject to physical damage, conductors shall be adequately protected.

E-300.05. Protection Against Corrosion.

Metal raceways, cable armor, boxes, cabinets and all metallic elbows, couplings, and fittings, unless made of corrosion-resistant material, shall be suitably protected against corrosion inside and outside (except threads at joints) by a coating of approved corrosion-resistant materials such as zinc, cadmium, or enamel. Ferrous raceways, fittings and boxes protected from corrosion solely by enamel may be used only indoors and in occupancies not subject to severe corrosive influences.

Note: Meat-packing plants, tanneries, hide cellars, casing rooms, glue houses, fertilizer rooms, salt storage, some chemical works, metal refineries, pulp mills, sugar mills, round houses, some stables, and similar locations are judged to be occupancies where severe corrosive conditions are likely to be present.

E-300.06. Raceways Exposed to Different Temperatures.

Where portions of an interior raceway system are exposed to widely different temperatures, as in refrigerating or cold-storage plants, provision shall be made to prevent circulation of air from a warmer to a colder section through the raceway.

Note: Consideration should be given to expansion and contraction of runs of conduit from temperature changes.

E-300.07. Underground Runs.

Conductors run underground shall comply with the provisions of E-230.032 as far as mechanical protection is concerned.

E-300.08. Through Studs, Joists and Rafters.

(1) Where exposed or concealed wiring conductors in insulating tubes or cables are installed through bored holes in studs, joists or similar wood members, holes shall be bored at the approximate centers of wood members, or at least two inches from the top edge.

(2) Where there is no objection because of weakening the building structure, armored or non-metallic sheathed cable and Type MI cable may be laid in notches no more than  $\frac{1}{4}$  span from either end in the studding or joists when the cable at those points is protected against the driving of nails into it by having the notch covered with a steel plate at least 1/16 inch in thickness before building finish is applied.

E-300.09. Grounding Metal Enclosures.

Metal raceways, boxes, cabinets, cable armor and fittings shall be grounded if and as prescribed in Chapter E-250.

E-300.10. Electrical Continuity of Metal Raceways and Enclosures.

Metal raceways, cable armor, and other metal enclosures for conductors, shall be metallically joined together into a continuous electrical conductor, and shall be so connected to all boxes, fittings and cabinets as to provide effective electrical continuity. Raceways and cable assemblies shall be mechanically secured to

boxes, fittings, cabinets and other enclosures, except as provided for non-metallic boxes in E-370.07.

E-300.11. Secured in Place.

Raceways, cable assemblies, boxes, cabinets and fittings shall, unless otherwise provided, be securely fastened in place, unless otherwise provided for specific purposes elsewhere in this Code.

E-300.12. Mechanical Continuity - Raceways and Cables.

Raceways and cable assemblies shall be continuous from outlet to outlet and from fitting to fitting.

E-300.13. Mechanical Continuity - Conductors.

Conductors shall be continuous between outlets, devices, etc., and, except as permitted for auxiliary gutters in E-374.08, and for wireways in E-362.06, there shall be no splice or tap within a raceway itself.

E-300.14. Free Length of Conductors at Outlets and Switch Points.

At least six inches of free conductor shall be left at each outlet and switch point for the making up of joints or the connection of fixtures or devices, except where conductors are intended to loop without joints through lampholders, receptacles and similar devices.

E-300.15. Boxes.

Except as permitted in E-336.11 and E-410.60, a box shall be installed at each outlet, switch, or junction point of conduit, electrical metallic tubing, surface metal raceway, armored cable, non-metallic sheathed or Type MI cable, and at each outlet and switch point of concealed knob-and-tube work.

E-300.16. Raceway or Cable to Open or Concealed Wiring.

(1) A box or terminal fitting having a separately bushed hole for each conductor shall be used wherever a change is made from conduit, electrical metallic tubing, non-metallic sheathed cable, armored cable or Type MI cable and surface metal raceway wiring to open wiring or to concealed knob-and-tube work. A fitting used for this purpose shall contain no taps or splices and shall not be used at

fixture outlets.

(2) A bushing may be used in lieu of a box or terminal fitting at ends of conduit or electrical metallic tubing where conductors leave the conduit or tubing behind a switchboard, or where more than 4 conductors leave the conduit or tubing at control apparatus or in similar locations, in which case the conductors shall be bunched, taped and painted with insulating paint. Such a bushing shall be of the insulating type except for lead-covered conductors.

E-300.17. Number of Conductors in Raceway.

In general the percentage of the total interior cross-sectional area of a raceway occupied by conductors shall not be more than will permit a ready installation or withdrawal of the conductors and dissipation of the heat generated without injury to the insulation of the conductors. See the following rules of this code: conduit, E-346.06; electrical metallic tubing, E-348.06; flexible metal conduit, E-350.03; surface metal raceways, E-352.04; underfloor raceways, E-354.05; cellular metal floor raceways, E-356.05; cellular concrete floor raceways, E-358.09; wireways, E-362.05; auxiliary gutters, E-374.05; theatres, E-520.05; signs, E-600.21(4); elevators, E-620.33; and sound recording, E-640.03 and E-640.04; and Remote-Control, Low-Energy Power, Low-Voltage Power and Signal Circuits, Chapter E-725.

E-300.18. Inserting Conductors in Raceways.

(1) Raceways shall first be installed as a complete raceway system without conductors, except those raceways exposed and having a removable cover or capping.

(2) As far as possible, conductors shall not be inserted until the interior of the building has been physically protected from the weather, and all mechanical work on the building which is likely to injure the conductors has been completed.

(3) Pull wires, if to be used, shall not be installed until the raceway system is in place.

(4) Graphite, talc, or an approved compound may be used as a lubricant in inserting conductors in raceways.

(5) Cleaning agents or lubricants that might have a deleterious effect on

conductor coverings shall not be used.

E-300.19. Supporting Conductors in Vertical Raceways.

(1) Conductors in vertical raceways shall be supported at intervals not greater than those specified in the following table:

No. 18	to No. 0 . . . . .	not greater than 100 feet
No. 00	to No. 0000 . . . . .	not greater than 80 feet
250,000 C. M.	to 350,000 C. M. . . . .	not greater than 60 feet
350,001 C. M.	to 500,000 C. M. . . . .	not greater than 50 feet
500,001 C. M.	to 750,000 C. M. . . . .	not greater than 40 feet
	Above 750,000 C. M. . . . .	not greater than 35 feet

(2) One of the following methods of support, or a method of equal effectiveness is recommended:

(a) By clamping devices constructed of or employing insulating wedges inserted in the ends of the conduits. With cables having varnished cambric or thermoplastic insulation it may also be necessary to clamp the conductor.

(b) By inserting boxes at the required intervals in which insulating supports are installed and secured in a satisfactory manner to withstand the weight of the conductors attached thereto, the boxes being provided with covers.

(c) In junction boxes, by deflecting the cables not less than 90 degrees and carrying them horizontally to a distance not less than twice the diameter of the cable, the cables being carried on two or more insulating supports, and additionally secured thereto by tie wires if desired. When this method is used cables shall be supported at intervals not greater than 20 per cent of those mentioned in the preceding tabulation.

E-300.20. Induced Currents in Metal Enclosures.

In metal raceway or cable armor, or where a current of more than 50 amperes enters a metal enclosure, the conductors of circuits operating on alternating-current shall be so arranged as to avoid overheating of the metal by induction. When the capacity of a circuit is such that it is impracticable to run all conductors in one enclosure, the circuit may be divided and two or more enclosures may be used provided each phase conductor of the circuit and the neutral conductor, where

one is used, are installed in each enclosure. The conductors of such an installation can conform to the provisions of E-310.10 for multiple conductors.

Note 1. Induced currents in an enclosure can be avoided by so grouping the conductors in one enclosure that the current in one direction will be substantially equal to the current in the opposite direction.

Note 2. In the case of circuits supplying vacuum or electric discharge lighting systems or signs, or X-ray apparatus, and under-plaster extensions permitted by E-344.01 to E-344.04 inclusive, the currents carried by the conductors are so small that a single conductor may be placed in a metal raceway or cable armor without causing trouble from induction.

Note 3. Where the conductors of a circuit pass through individual holes in the wall of a metal cabinet, the effect of induction may be minimized by

(1) cutting slots in the metal between the individual holes through which the conductors of the circuit pass, or

(2) passing all the conductors in the circuit through an insulating block used to cover a hole in the metal cabinet, sufficiently large for all the conductors of the circuit and providing individual holes in the insulating block for the separate conductors.

#### E-300.21. Prevention of Spread of Fire.

Electrical installations shall be so made that the possible spread of fire through fire-stopped partitions, hollow spaces, fire walls or fire partitions, vertical shafts, ventilating or air-conditioning ducts is reduced to a minimum.

#### E-300.22. Wiring in Ventilating and Exhaust Ducts.

(1) Where it is necessary to run a wiring system through air-conditioning ducts or plenum chambers, the wiring method shall be rigid conduit, flexible steel conduit with lead-covered conductors, or Type ACL armored cable, with fittings suitable for the location. The terminals of circuits of such wiring systems shall be so located that it will not be necessary to install motors or control equipment

in the ducts, except for temperature and humidity control. Raceways shall not interfere with the operation of automatic fire dampers in ducts.

(a) The above provisions shall not apply to integral fan systems specifically approved for the purpose.

(2) No wiring system of any type shall be installed in ducts for dust, loose stock or vapor removal.

E-300.23. Temporary Wiring.

(1) Suitable disconnecting switches or plug connectors shall be installed to permit the disconnection of all conductors of the temporary circuit by a single operation.

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



CHAPTER E-310

CONDUCTORS FOR GENERAL WIRING

E-310.01. General.

(1) The purpose of this Chapter is to assure that conductors have mechanical strength, insulation, and current carrying capacity 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.

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 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.

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

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions
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.
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 E-310.08.
Thermoplastic-Covered Fixture Wire - Flexible Stranding	*TFF	60°C 140°F	Fixture wiring.
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.

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

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions
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	Dry and wet locations. For over 2000 volts, insulation shall be ozone-resistant.
		75°C 167°F	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.

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

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions
Latex Rubber	RU	60°C 140°F	Dry locations.
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.
Moisture and Heat-Resistant Thermoplastic	THW	75°C 167°F	Dry and wet locations.
Mineral Insulation (Metal Sheathed)	MI	85°C 185°F	Dry and wet locations with Type O termination fittings. Max. operating temperature for special applications 250°C.
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 application 125°C.
Thermoplastic and Fibrous Outer Braid	TBS	90°C 194°F	Switchboard wiring only.

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions
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.
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 257°F	Dry locations only. In raceways, only for leads to or within apparatus. Limited to 300 V.
Asbestos	AIA	125°C 257°F	Dry locations only. Open wiring. In raceways, only for leads to or within apparatus.

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Trade Name	Type Letter	Max. Operating Temp.	Application Provisions
Paper		85°C 185°F	For underground service conductors, or by special permission.
Slow-Burning	SB	90°C 194°F	Dry locations only. Open wiring; and in raceways where temperatures will exceed those permitted for rubber-covered or varnished cambric-covered conductors.

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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
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	None

Table E-310.02(2) continued.

Trade Name	Type Letter	Insulation	Thickness of Insulation	Outer Covering																																				
Thermoplastic and Asbestos	TA	Thermoplastic and Asbestos	<table border="0"> <tr> <td></td> <td>Th<sup>t</sup> pl<sup>t</sup>.</td> <td>Asb.</td> <td></td> </tr> <tr> <td>14-8 . . .</td> <td>.20 Mils</td> <td>20 Mils</td> <td></td> </tr> <tr> <td>6-2 . . .</td> <td>.30 Mils</td> <td>25 Mils</td> <td></td> </tr> <tr> <td>1-4/0 . . .</td> <td>.40 Mils</td> <td>30 Mils</td> <td></td> </tr> </table>		Th <sup>t</sup> pl <sup>t</sup> .	Asb.		14-8 . . .	.20 Mils	20 Mils		6-2 . . .	.30 Mils	25 Mils		1-4/0 . . .	.40 Mils	30 Mils		Flame-retardant, cotton braid																				
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Silicone-Asbestos	SA	Silicone Rubber	<table border="0"> <tr> <td>14-10 . . . . .</td> <td>3/64 Inch</td> <td></td> <td></td> </tr> <tr> <td>8-2 . . . . .</td> <td>4/64 Inch</td> <td></td> <td></td> </tr> <tr> <td>1-4/0 . . . . .</td> <td>5/64 Inch</td> <td></td> <td></td> </tr> <tr> <td>213-500 . . . . .</td> <td>6/64 Inch</td> <td></td> <td></td> </tr> <tr> <td>501-1000 . . . . .</td> <td>7/64 Inch</td> <td></td> <td></td> </tr> <tr> <td>1001-2000 . . . . .</td> <td>8/64 Inch</td> <td></td> <td></td> </tr> </table>	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			Asbestos or glass												
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Thermoplastic and Fibrous Braid	TBS	Thermoplastic	<table border="0"> <tr> <td>14-10 . . . . .</td> <td>2/64 Inch</td> <td></td> <td></td> </tr> <tr> <td>8 . . . . .</td> <td>3/64 Inch</td> <td></td> <td></td> </tr> <tr> <td>6-2 . . . . .</td> <td>4/64 Inch</td> <td></td> <td></td> </tr> <tr> <td>1-4/0 . . . . .</td> <td>5/64 Inch</td> <td></td> <td></td> </tr> </table>	14-10 . . . . .	2/64 Inch			8 . . . . .	3/64 Inch			6-2 . . . . .	4/64 Inch			1-4/0 . . . . .	5/64 Inch			Flame-retardant, non-metallic covering																				
14-10 . . . . .	2/64 Inch																																							
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Mineral-Insulated Metal-Sheathed	MI	Magnesium Oxide	<table border="0"> <tr> <td>16-4 . . . . .</td> <td>.50 Mils</td> <td></td> <td></td> </tr> <tr> <td>3-4/0 . . . . .</td> <td>.55 Mils</td> <td></td> <td></td> </tr> </table>	16-4 . . . . .	.50 Mils			3-4/0 . . . . .	.55 Mils			Copper																												
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14-8 . . . . .	3/64 Inch																																							
6-2 . . . . .	4/64 Inch																																							
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Table E-310.02(2) continued.

Trade Name	Type Letter	Insulation	Thickness of Insulation				Outer Covering	
			1st Asb.	VC	AVA 2nd Asb.	AVL 2nd Asb.		
Asbestos and Varnished Cambric	AVA and AVL	Impregnated Asbestos and Varnished Cambric	1/4-8 . . . . .	10	30	15	25	AVA-asbestos braid or glass
			6-2 . . . . .	15	30	20	25	
			1-4/0 . . . . .	20	30	30	30	
			213-500 . . . . .	25	40	40	40	AVL-lead sheath
			501-1000 . . . . .	30	40	40	40	
			1001-2000 . . . . .	30	50	50	50	
Asbestos and Varnished Cambric	AVB	Impregnated Asbestos and Varnished Cambric			VC	Asb.	Flame-retardant, cotton braid (switchboard wiring)	
			18-8 . . . . .		30	20		
			6-2 . . . . .		40	30		
			1-4/0 . . . . .		40	40		
Asbestos and Varnished Cambric	AVB	Impregnated Asbestos and Varnished Cambric		Asb.	VC	2nd Asb.	Flame-retardant, cotton braid	
			1/4-8 . . . . .	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	1/4 . . . . .			30 Mils	Without asbestos braid	
			12-8 . . . . .			40 Mils		

Table E-310.02(2) continued.

-149-

Trade Name	Type Letter	Insulation	Thickness of Insulation	Outer Covering
Asbestos	AA	Asbestos	14 . . . . . .30 Mils 12-8 . . . . . .30 Mils 6-2 . . . . . .40 Mils 1-4/0 . . . . . .60 Mils	With asbestos braid or glass
Code	R	Code 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
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

\*For 14-12 sizes RHH shall be 3/64 inch thickness insulation.

Table E-310.02(2) continued.

-150-

Trade Name	Type Letter	Insulation	Thickness of Insulation	Outer Covering
Moisture and Heat-Resistant	RH-RW	Moisture and Heat Resistant Rubber	14-10 . . . . . $.3/64$ Inch	Moisture-resistant, flame-retardant, non-metallic 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	
Moisture and Heat-Resistant	RHW	Moisture and Heat Resistant Rubber	14-10 . . . . . $.3/64$ Inch	Moisture-resistant, flame-retardant, non-metallic 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	
Latex Rubber	RU	90% Unmilled, Grainless Rubber	14-10 . . . . . 18 Mils	Moisture-resistant, flame-retardant, non-metallic covering
			8-2 . . . . . 25 Mils	
	RUW	90% Unmilled, Grainless Rubber	14-10 . . . . . 18 Mils	Moisture-resistant, flame-retardant, non-metallic covering
			8-2 . . . . . 25 Mils	
Asbestos	AI	Impregnated Asbestos	14 . . . . . .30 Mils	Without asbestos braid
			12-8 . . . . . .40 Mils	

Table E-310.02(2) continued.

-151-

Trade Name	Type Letter	Insulation	Thickness of Insulation		Outer Covering	
			Sol.	Str.		
Asbestos	AIA	Impregnated Asbestos	14 . . . . .	.30 Mils	30 Mils	With asbestos braid or glass
			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		
Paper		Paper			Lead sheath	
Slow Burning	SB	3 Braids Impregnated Fire Retardant, Cotton Thread	14-10 . . . . .		3/64 Inch	Outer cover finished smooth and hard
			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	

Note: The fibrous covering over individual rubber-covered conductors of lead-sheathed or multiple-conductor cable is not required to be flame retardant. For armored cable, see E-334.02. For non-metallic-sheathed cable, see E-336.02. For Type UF cable, see E-339.01.

(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 slow-burning and 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. This may be omitted for slow-burning wires.

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

(4) Classification. In addition to the type letters specified in Table E-310.02(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 two insulated conductors laid parallel under an outer fibrous covering.

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

Note: 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.

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

(5) 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.

(6) Identified Conductors. Single insulated conductors of No. 6 or smaller, intended for use as identified conductors of circuits, except (a) for fixture wires as outlined below, and (b) for mineral insulated-metal sheathed cable, 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. (c) For fixture wires the identification shall be as above, or by means of 1. ridges, or 2. grooves, or 3. stripes colored white or natural gray so located on the exterior of the wires as to identify it.

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 herein.

(7) 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 E-200.06(2).

(8) Insulation Thickness - Over 600 Volts. The thickness of insulation for conductors for use at over 600 volts shall conform to Tables E-310.02(8)(a) through E-310.02(8)(d):

Table E-310.02(8)(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(8)(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(8) (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	..	..	..	..	..	..
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

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(8) (d)

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

Conductor AWG or MCM	1st Wall	Varnished Cambric					Asbestos
	Asbestos						2nd Wall
	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

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 E-373.06(2).

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.

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, rubber-covered (Type RHW); moisture-resistant, thermoplastic-covered (Type TW); moisture and heat-resistant, thermoplastic-covered (Type THW); lead covered; 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.

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 protection, such as a covering board, concrete pad, raceway, etc., may be required by the administrative authority.

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.

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 E-400.07; for fixture wire in E-410.18; for fractional horsepower motors in E-430.022; for cranes and hoists in E-610.14; for elevator control and signal circuits in E-620.12; for machine tools in E-670.21; and for remote-control, low-energy power, low voltage power and signal circuits in E-725.13.

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.

E-310.10. Conductors in Multiple.

Conductors in sizes 1/0 and larger may be run in multiple provided they are of the same length and have the same circular-mil area and type of insulation. Where conductors are run in multiple, they shall be arranged and terminate at both ends in such a manner as to insure equal division of the total current between all conductors that are involved.

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

E-310.11. Current-Carrying Capacity.

The maximum, continuous, current-carrying capacities of copper conductors are given in Tables E-310.12 and E-310.13. The current-carrying capacities of aluminum conductors are given in Tables E-310.14 and E-310.15.

Notes to Tables E-310.12 through E-310.15.

1. Explanation of Tables. For explanation of Type Letters, and for recog-

nized size of conductors for the various conductor insulations, see E-310.02 and E-310.03. For installation requirements, see 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 current-carrying capacities of Tables E-310.13 and E-310.15 shall be used. For all other recognized wiring methods, the allowable current-carrying capacities 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 current-carrying capacities 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 current-carrying capacity 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 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.

8. More Than Three Conductors in a Raceway or Cable. Tables E-310.12 and E-310.14 give the allowable current-carrying capacities 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 current-carrying capacity 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. When conductors of different systems, as provided in 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.

9. Where Type RH-RW rubber insulated wire is used in wet locations the allowable current-carrying capacities shall be those of Column 2 in Tables E-310.12 through E-310.15. Where used in dry locations the allowable current-carrying capacities 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.

11. Neutral Conductor. 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 current-carrying capacities as provided for in Note 8.

a. In a 3-wire circuit consisting of two phase wires and the neutral of a 4-wire, 3-phase 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 current-carrying capacities 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.

Table E-310.12. Allowable Current-Carrying Capacities of Insulated Copper Conductors in Amperes.

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

Size AWG MCM	Rubber		Paper		Asbestos		Impreg-nated Asbestos		Asbestos	
	Type R Type RW	Type RH	Type TA SA	Var-Cam Type V	Var-Cam Type AVA Type AVL	Type AI (14-8) Type ATA	Type A (14-8) Type AA			
14	15	15	25	30	30	30	30			30
12	20	20	30	35	40	40	40			40
10	30	30	40	45	50	50	50			55
8	40	45	50	60	65	65	65			70
6	55	65	70	80	85	85	85			95
4	70	85	90	105	115	115	115			120
3	80	100	105	120	130	130	130			145
2	95	115	120	135	145	145	145			165
1	110	130	140	160	170	170	170			190

Table E-310.12 continued.

-161-

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	280	335	360	420	450	...
500	320	380	405	470	500	...
600	355	420	455	525	545	...
700	385	460	490	560	600	...
750	400	475	500	580	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 TEMPS. 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

\*\*The current-carrying capacities for Type RHH conductors for sizes AWG 14, 12 and 10 shall be the same as designated for Type RH conductors in this Table.

Table E-310.13. Allowable Current-Carrying Capacities of Insulated Copper Conductors in Amperes

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

Size AWG MCM	Rubber Type R Type RW	Rubber Type RH	Thermo- plastic Asbestos Type TA SA	Asbestos Var-Cam Type AVA Type AVL	Impreg- nated Asbestos Type AI (14-8) Type AIA	Asbestos Type A (14-8) Type AA	Slow Burning Type SE
	Type RU Type RUW (14-2)	RUH (14-2)	Var-Cam Type V				
	Type RH-RW See Note 9	Type RH-RW See Note 9	Asbestos Var-Cam Type AVB				
	Thermo- plastic Type T Type TW	Type RHW	MI Cable				
		Thermo- plastic Type THW	RHH**				
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

Table E-310.13 continued.

-163-

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	...	...	...	905
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 TEMPS. 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	...

\*\*The current-carrying capacities for Type RHH conductors for sizes AWG 14, 12 and 10 shall be the same as designated for Type RH conductors in this Table.

Weatherproof-covered conductors used for service drops have the same current-carrying capacity as Type SB.



Table E-310.14. Allowable Current-Carrying Capacities of Insulated Aluminum Conductors in Amperes

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

Size AWG MCM	Rubber Type R, RW, RU, RUW (12-2)	Rubber Type RH	Thermo- plastic Asbestos Type TA SA	Asbestos Var-Cam Type AVA Type AVL	Impreg- nated Asbestos Type AI (14-8) Type AIA	Asbestos Type A (14-8) Type AA
	Type RH-RW Note 9	RUH (14-2)	Var-Cam Type V			
	Thermo- plastic Type T TW	Type RH-RW Note 9	Asbestos Var-Cam Type AVB			
		Type RHW	MI Cable			
		Thermo- plastic Type THW	RHH**			
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	...

Table E-310.14 continued.

-165-

1250	405	485	530	...	...	...
1500	435	520	580	650	...	...
1750	455	545	615	...	...	...
2000	470	560	650	705	...	...

## CORRECTION FACTORS, ROOM TEMPS. 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

\*For three wire, single phase service and sub-service circuits, the allowable current-carrying capacity 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 current carrying capacities for Type RHH conductors for sizes AWG 12, 10 and 8 shall be the same as designated for Type RH conductors in this Table.

Table E-310.15. Allowable Current-Carrying Capacities of Insulated Aluminum Conductors in Amperes

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

Size AWG MCM	Rubber Type R, RW, RU, RUW (12-2)	Rubber Type RH	Thermo- plastic Asbestos Type TA SA	Asbestos Var-Cam Type AVA Type AVL	Impreg- nated Asbestos Type AI (14-8) Type AIA	Asbestos Type A (14-8) Type AA	Slow Burning Type SB
	Type RH-RW Note 9	RUH (14-2)	Var-Cam Type V				
	Thermo- plastic Type T, TW	Type RH-RW Note 9	Asbestos Var-Cam Type AVB				
		Type RHW	MI Cable				
		Thermo- plastic Type THW	RHH**				
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	150	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	355	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	930	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 TEMPS. 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

\*\*The current-carrying capacities for Type RHH conductors for sizes AWG 12, 10 and 8 shall be the same as designated for Type RH conductors in this Table.

Weatherproof-covered conductors used for service drops have the same current-carrying capacity as Type SB.

CHAPTER E-320

OPEN WIRING ON INSULATORS

E-320.01. Definition.

Open wiring is a wiring method using cleats, knobs, tubes and flexible tubing for the protection and support of insulated conductors run in or on buildings, and not concealed by the building structure.

E-320.02. Use.

(1) Open wiring on insulators may be used for exposed work, either inside or outside building; in dry or wet locations; where subject to corrosive vapors such as covered by Chapter E-480; for services as covered by Chapter E-230, provided the requirements of this Chapter are satisfied.

(2) Open wiring on insulators shall not be used (a) in commercial garages, (b) in theaters, (c) in motion-picture studios, (d) in hoistways, and (e) in hazardous locations, except in storage compartments of Class III locations as provided in E-503.03(2).

E-320.03. Other Chapters.

In addition to the provisions of this Chapter, open wiring shall conform to the other applicable provisions of this Code. See especially Chapters E-300 and E-730.

E-320.04. Conductors.

The type of conductors shall conform to Chapter E-310. Only single conductors shall be used.

(1) The allowable current-carrying capacities of insulated conductors as shown in Tables E-310.13 and E-310.15 shall apply to open wiring on insulators.

E-320.05. Supports.

(1) Conductors shall not be in contact with any object other than their insulating supports. They shall be rigidly supported on noncombustible, non-absorptive insulating material as follows:

(a) Under ordinary circumstances, supports for wiring over flat surfaces shall be not more than  $4\frac{1}{2}$  feet apart. Where the conductors are likely to be dis-

turbed, the distance between supports shall be shortened sufficiently to provide adequate support for conductors;

(b) Conductors shall be supported within 6 inches of a tap;

(c) Conductors shall not be dead ended at a rosette, lampholder, or receptacle unless the last support is within 12 inches of the device.

(2) The following exceptions to the provisions of E-320.05(1) may be permitted:

Exception No. 1. For use of non-metallic flexible tubing, see E-320.07.

Exception No. 2. Conductors of No. 8 or larger installed in the open across open spaces where not likely to be disturbed, may be supported at distances not greater than 15 feet provided that approved noncombustible, non-absorptive insulating separators assuring not less than  $2\frac{1}{2}$  inch separation between conductors, are installed at intervals of not over  $4\frac{1}{2}$  feet.

Exception No. 3. In buildings of mill construction where not likely to be disturbed, feeders in the open, not smaller than No. 8, may be separated about six inches and installed direct from timber to timber, being supported from each timber only.

(3) When nails are used to mount knobs they shall not be smaller than 10 penny. When screws are used to mount knobs, or when nails or screws are used to mount cleats, they shall be of a length sufficient to penetrate the wood to a depth equal to at least one-half the height of the knob and fully the thickness of the cleat. Cushion washers shall be used with nails.

#### E-320.06. Conductor Separation.

Open conductors shall be separated as follows:

(1) For voltage not exceeding 300 volts between conductors,  $2\frac{1}{2}$  inches from each other and shall be separated from the surface wired over at least  $\frac{1}{2}$  inch in dry locations.

(2) For voltages of 301 to 600 volts between conductors, 4 inches from each

other and shall be separated from surface wired over at least 1 inch.

(3) In damp or wet locations, a separation of at least 1 inch from the surface wired over shall be maintained for all voltages.

E-320.07. Flexible Non-metallic Tubing.

In dry locations, when not exposed to severe physical damage, conductors may be separately encased in flexible tubing. Tubing shall be in continuous length not exceeding 15 feet, and secured to the surface wired over by straps spaced not exceeding  $4\frac{1}{2}$  feet apart.

E-320.08. Tie Wires.

No. 8 or larger conductors supported on solid knobs shall be securely tied thereto. Tie wires shall have a covering equivalent to conductors which they confine.

E-320.09. Passing Through Walls and Floors.

Open conductors shall be separated from contact with walls, floors, timbers or partitions through which they pass by tubes or bushings of noncombustible, non-absorptive insulating material. Where the bushing is shorter than the hole, a water-proof sleeve of non-inductive material shall be inserted in the hole and an insulating bushing slipped into the sleeve at either end in such a manner as to keep the conductors absolutely out of contact with the sleeve. Each conductor must be carried through a separate tube or sleeve.

E-320.10. Separation from Metal Work.

Open conductors shall be separated at least 2 inches from metallic conduit, piping, or other conducting material, and from any exposed lighting, power or signal conductor, or shall be separated therefrom by a continuous and firmly fixed non-conductor additional to the insulation of the conductor. Where any insulating tube is used, it shall be secured at the ends. Deviation from this requirement may, when necessary, be allowed by the administrative authority.

E-320.11. Separation from Piping in Damp Locations.

Open conductors located close to water pipes or tanks, or in other damp

locations, shall be so placed that an air space will be permanently maintained between them and pipes which they cross. Where practicable, conductors shall be installed over, rather than under, pipes upon which moisture is likely to gather or which may leak.

E-320.12. Protection from Physical Damage.

Where open conductors cross ceiling joists and wall studs, and are exposed to physical damage, they shall be protected by one of the following methods. Conductors within 8 feet from the floor shall be considered exposed to physical damage.

(1) By guard strips not less than  $7/8$  inch in thickness and at least as high as the insulating supports, placed on each side of and close to the wiring.

(2) By a substantial running board at least  $\frac{1}{2}$  inch thick back of the conductors with side protections. Running boards shall extend at least 1 inch outside the conductors, but not more than 2 inches and the protecting sides shall be at least 2 inches high and at least  $7/8$  inch thick.

(3) By boxing made as above and furnished with cover kept at least 1 inch away from the conductors within. Where protecting vertical conductors on side walls the boxing shall be closed at the top and the holes through which the conductors pass shall be bushed.

(4) By rigid metal conduit or electrical metallic tubing, in which case the rules of Chapters E-346 or E-348 shall apply; or by metal piping, in which case the conductors shall be encased in continuous lengths of approved flexible tubing. The conductors passing through metal enclosures shall be so grouped that current in both directions is approximately equal.

E-320.13. <sup>In</sup> Accessible Attics.

Conductors in unfinished attics or roof spaces shall be installed in accordance with the provisions of E-324.08.

E-320.14. Entering Spaces Subject to Dampness, Wetness or Corrosive Vapors.

Conductors entering or leaving locations subject to dampness, wetness or



corrosive vapors shall have drip loops formed on them and shall then pass upward and inward from the outside of buildings, or from the damp, wet, or corrosive location, through noncombustible, non-absorptive insulating tubes. See also E-230.049 and E-730.21.

E-320.15. Switches.

(1) Surface-type snap switches shall be mounted in accordance with the provisions of E-380.10. Metal boxes are not required. See E-380.03.

(2) Other types of switches shall be installed in accordance with the provisions of E-380.03.

CHAPTER E-324

CONCEALED KNOB-AND-TUBE WORK

E-324.01. Definition.

Concealed knob-and-tube wiring is a wiring method using knobs, tubes and flexible non-metallic tubing for the protection and support of insulated conductors concealed in hollow spaces of walls and ceilings of buildings.

E-324.02. Use.

Concealed knob-and-tube work may be used in the hollow spaces of walls and ceilings. It shall not be used (1) in commercial garages, (2) in theaters, except as provided in E-520.04, (3) in motion-picture studios, nor (4) in hazardous locations.

E-324.03. Other Chapters.

In addition to the provisions of this Chapter, concealed knob-and-tube wiring shall conform to the other applicable provisions of this Code. See especially Chapter E-300.

E-324.04. Conductors.

Only single conductors shall be used. The type of conductors shall conform to Chapter E-310.

E-324.05. Supports.

Conductors shall be supported at intervals not exceeding  $4\frac{1}{2}$  feet by knobs or tubes of noncombustible, non-absorptive, insulating material. There shall be a knob within 6 inches from each tap. Tie wires shall comply with E-320.08. Where such support is impracticable and the conductors are in a dry location, they may be fished when separately enclosed in flexible non-metallic tubing extending in continuous lengths from one support to the next or to a box, or from one box to another.

E-324.06. Conductor Separation.

(1) Conductors shall be separated at least 3 inches and maintained at least 1 inch from the surface wired over.

(2) At distributing centers, meters, outlets, switches or other places where space is limited and the 3-inch separation cannot be maintained, each conductor shall be encased in a continuous length of flexible tubing.

(3) Where practicable, conductors shall be run singly on separate timbers or studding.

E-324.07. Separation from Other Objects and Protection.

Conductors shall be separated from other conductors and objects as follows:

(1) The provisions as to rigid supporting and clearance from foreign wires and other objects, as specified for open wiring in E-320.09, E-320.10, E-320.11, and E-320.15, shall be complied with.

(2) Conductors passing through cross timbers in plastered partitions shall be protected by an additional noncombustible, non-absorptive insulating tube extending at least 3 inches above the timber.

E-324.08. In Unfinished Attics and Roof Spaces.

Conductors in unfinished attics or roof spaces shall comply with the following:

(1) Conductors in unfinished attics and roof spaces shall be run through or on the sides of joists, studs and rafters, except in attics and roof spaces having head room at all points of less than 3 feet in buildings completed before the wiring is installed.

(2) Where conductors in accessible unfinished attics or roof spaces reached by stairway or permanent ladder are run through bored holes in floor joists or through bored holes in studs or rafters within 8 feet of the floor or floor joists, such conductors shall be protected by substantial running boards extending at least 1 inch on each side of the conductors and securely fastened in place.

(3) Where carried along the sides of rafters, studs or floor joists, neither running boards nor guard strips will be required.

E-324.09. Boxes of Insulating Material.

Non-metallic outlet boxes may be used as provided in E-370.03 and E-370.07.

E-324.10. Switches. See E-380.03 and E-380.10.

CHAPTER E-328

BARE-CONDUCTOR FEEDERS

E-328.01. Use.

By special permission, bare conductors installed in accordance with the provisions of E-300.01 to E-300.22 inclusive and in accordance with the provisions of E-328.02 to E-328.07 inclusive may be used for feeders only. Such bare conductors may be installed only in a chase, channel or shaft of noncombustible material in a building of fire-resistive construction; and only where the voltage between conductors does not exceed 600 volts. Bare conductors shall not be used in damp or wet locations, nor in any hazardous location, nor where subject to corrosive vapor, except in storage-battery rooms as provided in E-480.07.

E-328.02. Size and Capacity of Copper Conductors.

The maximum permissible current shall be 1000 amperes per square inch of cross-sectional area of conductor in unventilated enclosures, and 1200 amperes per square inch in ventilated enclosures. These provisions are not intended to apply to equipment such as controls and switchgear.

E-328.03. Branch Taps.

Branch taps from bare-conductor feeders may be installed as specified in E-240.15; provided that the mechanical protection specified by Exceptions No. 5 and 6 of E-240.15 shall not be required for that portion of the conductor located in the chase, channel or shaft.

E-328.04. Accessibility.

The conductors shall not be accessible to other than qualified persons.

E-328.05. Supports.

Conductors shall be supported as follows:

- (1) Conductors shall be supported on noncombustible, non-absorptive insulating supports of adequate mechanical strength.

(2) Conductors shall be so supported that a separation between conductors, and between conductors and ground, of not less than that specified in E-384.26 will be maintained under all conditions of operation.

E-328.06. Fire Cutoffs.

Where floors are pierced, suitable cutoffs against vertical travel of fire shall be provided. See also E-300.21.

E-328.07. Special Safeguards.

In addition to the provisions of the preceding rules, the administrative authority may require other safeguards in view of special conditions that may be met in a particular installation.

CHAPTER E-330

MINERAL INSULATED-METAL  
SHEATHED CABLE  
Type MI  
A. General

E-330.01. Definition and Construction.

For the purpose of this Chapter, mineral insulated-metal sheathed Type MI cable is a cable in which one or more electrical conductors are insulated with a highly compressed refractory mineral insulation and enclosed in a liquidtight and gastight metallic tube sheathing. It shall be used with approved fittings for terminating and connecting to boxes, outlets and other equipment.

E-330.02. Use.

Mineral insulated-metal sheathed cable may be used for services, feeders and branch circuits in both exposed and concealed work, in dry or wet locations; in Class I, Class II, and Class III hazardous locations as noted in the appropriate Chapters; for under plaster extensions as provided in Chapter E-344; and embedded in plaster finish on brick or other masonry. It may be used where exposed to weather or continuous moisture, for underground runs and embedded in masonry, concrete or fill, in buildings in course of construction or where exposed to oil, gasoline, or other conditions not having a deteriorating effect on the metal sheath. The sheath of mineral insulated-metal sheathed cable exposed to destructive corrosive conditions, such as some types of cinder fill, shall be protected by materials suitable for those conditions.

E-330.03. Other Chapters.

In addition to the provisions of this Chapter, the installation of mineral insulated-metal sheathed cable shall comply with the other applicable provisions of this Code. See especially Chapter E-300.

B. Installation

E-330.04. Supports.

Mineral insulated-metal sheathed cable shall be securely supported by approved staples, straps, hangers or similar fittings, so designed and installed as not to injure the cable. Cable shall be secured at intervals not exceeding 6 feet except where cable is fished.

E-330.05. Through Studs, Joists and Rafters.

See E-300.08.

E-330.06. Wet Locations.

In portions of dairies, laundries, canneries, and other wet locations, and in locations where walls are frequently washed, the entire wiring system, including all boxes and fittings used therewith, shall be made watertight and the cable shall be mounted so that there is at least one-quarter inch air space between it and the wall or other supporting surface.

E-330.07. Bends.

All bends shall be so made that the cable will not be damaged and the radius of the curve of the inner edge of any bend shall be not less than 5 times the diameter of the cable.

E-330.08. Terminating Seal.

At all points where mineral insulated-metal sheathed cable terminates an approved seal shall be provided immediately after stripping to prevent entrance of moisture into the mineral insulation. The conductors extending beyond the sheath shall be insulated with an approved insulating material.

E-330.09. Fittings.

When Type MI cable is connected to boxes or equipment, the fittings shall be approved for the conditions of service. When single conductor Type MI cables enter metal boxes through separate openings, refer to E-300.20.

E-330.10. Insulation Resistance.

The completed wiring system shall be tested for insulation resistance in accordance with E-195.19.

C. Construction Specifications

E-330.11. General.

Type MI cable for 600 volts shall conform to the following:

(1) Conductors. The conductors are solid copper and have cross sectional areas corresponding to the standard American Wire Gauge sizes.

(2) Insulation. The insulation is a highly compressed refractory mineral which provides proper spacing for the conductors.

(3) Outer Sheath. The outer sheath shall be of a continuous copper construction to provide mechanical protection and a moisture seal, and an adequate path for grounding purposes.



CHAPTER E-334

ARMORED CABLE

Types AC, ACT, ACV and ACL

E-334.01. Definition.

An armored cable is a fabricated assembly of insulated conductors and a flexible metallic covering.

E-334.02. General.

Armored cable for 600 volts or less shall conform to the following:

(1) A armor. All types of armored cables except Types ACL and ACV, in all sizes, shall have an internal bonding strip of either copper or aluminum in intimate contact with the armor for its entire length.

(2) Marking. The provisions of E-310.02 shall apply, except ready identification of the maker shall be by distinctive external markers in the cable armor throughout its entire length.

E-334.03. Use.

Armored cable (Type AC or ACT) may be used for both exposed work and concealed work in dry locations; for underplaster extensions as provided in Chapter E-344; and embedded in plaster finish on brick or other masonry, except in damp or wet locations. Armored cable (ACV) may be used only for exposed work in dry locations in buildings used for industrial or commercial purposes, and shall not be smaller than No. 4, except where approved for over 600 volts under E-710.03 and E-710.32. Armored cable shall contain lead-covered conductors (Type ACL), if used where exposed to the weather or to continuous moisture, for underground runs and embedded in masonry, concrete or fill in buildings in course of construction, or where exposed to oil, gasoline or other conditions having a deteriorating effect on the insulation. Armored cable may be run or fished in the air voids of masonry block or tile walls where such walls are not exposed or subject to excessive moisture or

dampness and not below grade line. Armored cable shall not be used (1) in theaters, except as provided in E-520.04; (2) in motion-picture studios; (3) in any hazardous locations; (4) where exposed to corrosive fumes or vapors; (5) on cranes or hoists, except as provided in E-610.11 Exception No. 3; (6) in storage battery rooms; nor (7) in hoistways or on elevators, except as provided in E-620.21.

E-334.04. Other Chapters.

In addition to the provisions of this Chapter, armored cable shall conform to other applicable provisions of this Code. See especially Chapter E-300.

E-334.05. Supports.

Armored cable shall be secured by approved staples, straps, or similar fittings, so designed and installed as not to injure the cable. Cable shall be secured at intervals not exceeding  $4\frac{1}{2}$  feet and within 12 inches from every outlet box or fitting, except where cable is fished and except lengths of not over 24 inches at terminals where flexibility is necessary.

E-334.06. Exposed Work.

Exposed runs of cable shall closely follow the surface of the building finish or of running boards, except:

- (1) Lengths of not more than 24 inches at terminals where flexibility is necessary.
- (2) In accessible attics and roof spaces, for which see E-334.08.
- (3) On the underside of floor joists in basements where supported at each joist and so located as not to be subject to physical damage.

E-334.07. Through Studs, Joists and Rafters.

See E-300.08

E-334.08. In Accessible Attics.

Cable in accessible attics or roof spaces shall be installed as follows:

- (1) Where run across the top of floor joists, or within 7 feet of floor or floor joists, across the face of rafters or studding, in attics and roof spaces which are accessible, the cable shall be protected by substantial guard strips which are

at least as high as the cable. Where this space is not accessible by permanent stairs or ladders, protection will only be required within 6 feet of the nearest edge of scuttle hole or attic entrance.

(2) Where cable is carried along the sides of rafters, studs or floor joists, neither guard strips nor running boards shall be required.

E-334.09. Protection at Cable Ends.

At all points where the armor terminates, a fitting shall be provided to protect wires from abrasion, unless the design of the outlet boxes or fittings is such as to afford equivalent protection, and in addition, an approved insulating bushing or its equivalent approved protection shall be provided between the conductors and the armor. The connector or clamp by which the armored cable is fastened to boxes or cabinets shall be of such design that the insulating bushing or its equivalent will be visible for inspection. This bushing is not required with lead-covered cables which shall be so installed that the lead sheath will be visible for inspection. Where change is made from armored cable to other cable or raceway wiring methods, an outlet box shall be installed at junction point as required in E-300.15.

E-334.10. Bends.

All bends shall be so made that the armor of the cable will not be injured, and the radius of the curve of the inner edge of any bend shall be not less than 5 times the diameter of the cable.

E-334.11. Boxes and Fittings.

See appropriate rules in Chapter E-370.

E-334.12. Switches.

See E-380.03.

E-334.13. Conductors.

Conductors used in armored cable for 600 volts or less shall comply with the requirements for the type of conductors used. Additional protection for the

conductors shall be provided as follows: In Type AC, the conductors shall have an over-all moisture-resistant and flame-retardant fibrous covering; in Type ACT, the individual conductors only shall have a moisture-resistant fibrous covering.

CHAPTER E-336

NON-METALLIC SHEATHED CABLE

Types NM and NMC

E-336.01. Definition.

A non-metallic sheathed cable is an assembly of two or more insulated conductors having an outer sheath of moisture-resistant, flame-retardant, non-metallic material.

E-336.02. Construction.

Non-metallic sheathed cable shall be an approved Type NM or NMC in sizes No. 14 to 4 AWG inclusive. In addition to the insulated conductors, the cable may have an approved size of uninsulated or bare conductor for grounding purposes only.

(1) Type NM. The conductors shall comply with the requirements for the type of conductor used. Overall fibrous coverings shall have a flame-retardant and moisture-resistant finish.

(2) Type NMC. The cable shall be of a type approved for the purpose. The over-all covering shall be flame-retardant, moisture-resistant, fungus-resistant and corrosion-resistant.

(3) Marking. In addition to the provisions of Chapter E-310, the cable shall carry distinctive marker on exterior for its entire length, specifying cable type, and the name of the manufacturing company.

E-336.03. Use.

Non-metallic sheathed cable may be installed for both exposed and concealed work as follows:

(1) Type NM. This type of non-metallic sheathed cable may be installed for both exposed and concealed work in normally dry locations. It may be installed or fished in air voids in masonry block or tile walls where such walls are not exposed or subject to excessive moisture or dampness. Type NM cable shall not be installed where exposed to corrosive fumes or vapors; nor shall it be embedded in masonry,

concrete, fill or plaster; nor run in shallow chase in masonry or concrete and covered with plaster or similar finish.

(2) Moisture and Corrosion-Resistant Type NMC. This type of non-metallic sheathed cable may be installed for both exposed and concealed work in dry, moist, damp or corrosive locations, and in outside and inside walls of masonry block or tile. Where embedded in plaster or run in a shallow chase in masonry walls and covered with plaster within 2 inches of the finished surface, it shall be protected against damage from nails by a cover of corrosion-resistant coated steel at least 1/16 inch in thickness and 3/4 inch wide in the chase or under the final surface finish.

(3) Uses Not Permissible for Either Type NM or NMC Non-Metallic Sheathed Cable. These types shall not be used as: (1) Service-entrance cable, (2) in commercial garages, (3) in theatres except as provided in E-520.04, (4) in motion picture studios, (5) in storage battery rooms, (6) in hoistways, (7) in any hazardous location, (8) embedded in poured cement, concrete or aggregate.

#### E-336.04. Other Chapters.

In addition to the provisions of this Chapter, installations of non-metallic sheathed cable shall conform to the other applicable provisions of this Code. See especially Chapter E-300.

#### E-336.05. Supports.

Non-metallic sheathed cable shall be secured by approved staples, straps, or similar fittings, so designed and installed as not to injure the cable. Cable shall be secured in place at intervals not exceeding  $4\frac{1}{2}$  feet and within 12 inches from every cabinet, box or fitting, except that in concealed work in finished buildings or finished panels for prefabricated buildings where such supporting is impracticable, the cable may be fished between points of access.

#### E-336.06. Exposed Work - General.

In exposed work, except as provided in E-336.08 and E-336.09, the cable shall be

installed as follows:

(1) The cable shall closely follow the surface of the building finish or of running boards.

(2) It shall be protected from physical damage where necessary, by conduit, pipe, guard strips or other means. Where passing through a floor the cable shall be enclosed in rigid metal conduit or metal pipe extending at least 6 inches above the floor.

E-336.07. Through Studs, Joists and Rafters.

See E-300.08.

E-336.08. In Unfinished Basements.

Where the cable is run at angles with joists in unfinished basements, assemblies not smaller than two No. 6 or three No. 8 conductors may be secured directly to the lower edges of the joists; smaller assemblies shall either be run through bored holes in the joists or on running boards. Where run parallel to joists, cable of any size shall be secured to the sides or face of the joists.

E-336.09. In Accessible Attics.

Cable in accessible attics or roof spaces shall also conform with E-334.08.

E-336.10. Bends.

Bends in cable shall be so made, and other handling shall be such, that the protective coverings of the cable will not be injured, and no bend shall have a radius less than 5 times the diameter of the cable.

E-336.11. Devices of Insulating Material.

(1) Switch, outlet, and tap devices of insulating material may be used without boxes in exposed cable wiring, and for concealed work for rewiring in existing buildings where the cable is concealed and fished. Openings in such devices shall form a close fit around the outer covering of the cable and the device shall fully enclose that part of the cable from which any part of the covering has been removed.

(2) Where connections to conductors are by binding screw terminals, there shall be available as many terminals as conductors, unless cables are clamped within the structure and terminals are of a type approved for multiple conductors.

E-336.12. Boxes of Insulating Material.

Non-metallic outlet boxes approved for the purpose may be used as provided in E-370.03.



CHAPTER E-338

SERVICE-ENTRANCE CABLE

Types ASE, SE and USE

E-338.01. Definition.

Service-entrance cable is an assembly of two or more conductors, one of which may be uninsulated, provided with a suitable over-all covering, primarily used for services and conforming with one of the following types:

- (1) Type ASE, having inherent protection against mechanical abuse and a flame-retardant, moisture-resistant covering.
- (2) Type SE, having a flame-retardant, moisture-resistant covering, but not required to have inherent protection against mechanical abuse.
- (3) Type USE, recognized for underground use, having a moisture-resistant covering, but not required to have a flame-retardant covering or inherent protection against mechanical abuse.

E-338.02. Use as Service-Entrance Conductors.

Service-entrance cable used as service-entrance conductors shall be installed as required by Chapter E-230.

E-338.03. Use as Branch Circuit or Feeders.

(1) Service-entrance cables may be used in interior wiring systems where all of the circuit conductors of the cable are of the rubber-covered or thermoplastic type.

(2) Service-entrance cables without individual insulation on the grounded conductor may be used only for range, wall-mounted oven and counter-mounted cooking unit, and clothes dryer circuits, or as feeders from a service cabinet to supply other buildings, or as service-entrance conductors for such other buildings, when the following conditions are met:

- (a) The cable has a final non-metallic outer covering.

(b) The supply is alternating current not exceeding 150 volts to ground.

Note: The above provisions do not intend to deny the use of service-entrance cable for interior use when the fully insulated conductors are used for circuit wiring and the uninsulated conductor is used for equipment grounding purposes.

(3) Service-entrance cable used to supply appliances shall not be subject to conductor temperatures in excess of the temperature specified for the type of insulation involved.

E-338.04. Installation Methods.

(1) In addition to the provisions of this Chapter, service-entrance cable used for interior wiring shall comply with the applicable provisions of Chapter E-300.

(2) Cable with metal interlocking armor shall be installed in accordance with the applicable provisions of Chapter E-334.

(3) Unarmored cable shall be installed in accordance with the applicable provisions of Chapter E-336.

(4) Cables through studs, joists and rafters shall be installed as required in E-300.08.

E-338.05. Marking.

Service-entrance cable shall conform with the marking required in E-310.02. Cable with the neutral conductor smaller than the ungrounded conductors shall be so marked.

CHAPTER E-339

UNDERGROUND FEEDER AND BRANCH CIRCUIT CABLE

Type UF

E-339.01. Description and Marking.

(1) Description. Underground feeder and branch circuit cable shall be an approved Type UF cable in sizes No. 14 to No. 4/0 AWG, inclusive. The conductors shall be Types RW, TW, RUW, RHW, or other conductors approved for the purpose. In addition to the insulated conductors, the cable may have an approved size of uninsulated or bare conductor for grounding purposes only. The over-all covering shall be flame-retardant, moisture-resistant, fungus-resistant and corrosive-resistant, and suitable for direct burial in the earth.

(2) Marking. In addition to the provisions of E-310.02, the cable shall carry distinctive markers on exterior for its entire length, specifying cable type, and the name of manufacturing company.

E-339.02. Other Chapters.

In addition to the provisions of this Chapter, installations of underground feeder and branch circuit cable (Type UF) shall comply with other applicable provisions of this Code. See especially Chapter E-300 and <sup>rule</sup> E-310.02(2).

E-339.03. Use.

(1) Underground feeder and branch circuit cable may be used underground, including direct burial in the earth, as feeder or branch circuit cable when provided with overcurrent protection not in excess of the rated current carrying capacity of the individual conductors.

(2) Where single conductor cables are installed, all cables of the feeder circuit, sub-feeder circuit, or branch circuit, including the neutral conductor, if any, shall be run together in the same trench or raceway.

(3) Where buried directly in the earth, supplementary mechanical protection,

such as a covering board, concrete pad, raceway, etc. when considered necessary, may be required by the administrative authority.

(4) Type UF cable may be used for interior wiring in wet, dry, or corrosive locations under the recognized wiring methods of this Code, and when installed as non-metallic sheathed cable it shall conform with the provisions of Chapter E-336 and shall be of the multiple conductor type.

(5) This type of cable shall not be used: (1) as service-entrance cable, (2) in commercial garages, (3) in theatres except as provided in E-520.04; (4) in motion picture studios, (5) in storage battery rooms, (6) in hoistways, (7) in any hazardous location, (8) embedded in poured cement, concrete or aggregate.

E-339.04. Overcurrent Protection.

Overcurrent protection shall be provided in accordance with provisions of E-240.05.

E-339.05. Rated Current-Carrying Capacity.

The current-carrying capacity of conductors in Type UF cable shall be according to Tables E-310.12 and E-310.14.

CHAPTER E-342

NON-METALLIC SURFACE EXTENSIONS

E-342.01. Description.

Non-metallic surface extension is an assembly of two insulated conductors within a non-metallic jacket and intended for mounting directly on the surface of walls or ceilings.

E-342.02. Other Chapters.

In addition to the provisions of this Chapter, non-metallic surface extensions shall conform to other applicable provisions of this Code.

E-342.03. Use Permitted.

A non-metallic surface extension may be used only where all of the following conditions are met:

- (1) The extension is from existing outlets on branch circuits.
- (2) The extension is run exposed.
- (3) The extension is in a dry location.
- (4) The area in which the extension is located is occupied for residential

or office purposes.

E-342.04. Use Prohibited.

An extension shall not be installed:

- (1) In unfinished basements, attics, or roof spaces.
- (2) Where voltage exceeds 150 volts between conductors.
- (3) Where subject to corrosive vapors.

E-342.05. Location in Room.

One or more extensions may be run in any direction from an existing outlet, but not on the floor <sup>or</sup> within 2 inches from the floor.

E-342.06. Outlets Per Circuit.

The total number of outlets supplied by one branch circuit, including those

previously installed and those of the extension, shall be in conformity with the requirements of Chapter E-210.

E-342.07. Not to Run Outside Room.

An extension shall not be run through a floor or partition, nor outside the room in which it originates.

E-342.08. Supports.

Non-metallic surface extensions shall be secured in place by approved means at intervals not exceeding 8 inches, except that where connection to the supplying outlet is made by means of an attachment plug the first fastening may be placed 12 inches or less from the plug. There shall be at least one fastening between each two adjacent outlets supplied. An extension shall be attached only to wood-work or plaster finish, and shall not be in contact with any metal work or other conductive material except the metal plates on receptacles.

E-342.09. Splices and Taps.

Extensions shall consist of a continuous unbroken length of the assembly, without splices, and without exposed conductors between fittings. Taps may be made where fittings completely covering the tap connections are used.

E-342.10. Bends.

A bend which reduces the normal spacing between the conductors shall be covered with a cap to protect the assembly from physical damage.

E-342.11. Fittings.

Each run shall terminate in a fitting which covers the end of the assembly. All fittings and devices shall be of a type approved for the purpose.

CHAPTER E-344

UNDERPLASTER EXTENSIONS

E-344.01. Use.

An underplaster extension installed as permitted by this Chapter, may be used only for extending an existing branch circuit in a building of fire-resistive construction.

E-344.02. Materials.

Such extensions shall be run in rigid or flexible conduit, armored cable, electrical metallic tubing, Type MI cable or metal raceways approved for the purpose. Standard sizes of conduit, cable, tubing and raceways shall be used except that for a single conductor only conduit or tubing having not less than 5/16 inch inside diameter, single-conductor armored cable or single conductor Type MI cable may be used.

E-344.03. Box and Fittings.

See Chapter E-370.

E-344.04. Installation.

An underplaster extension shall be laid on the face of masonry or other material and buried in the plaster finish of ceilings or walls. The methods of installation of the raceway or cable for such extension shall be as specified elsewhere in this Code for the particular type of material used, except that where alternating current is to be employed, all of the conductors of a circuit need not be contained in a single raceway or cable.

E-344.05. Extension to Another Floor.

No such extension shall extend beyond the floor on which it originates unless installed in a standard size of rigid metal conduit, electrical metallic tubing, armored cable, or MI cable.

CHAPTER E-346

RIGID METAL CONDUIT

E-346.01. Use.

Rigid metal conduit may be used under all atmospheric conditions and occupancies, except that ferrous raceways and fittings protected from corrosion solely by enamel may be used only indoors and in occupancies not subject to severe corrosive influences. Conduits and fittings exposed to severe corrosive influences shall be of corrosion-resistant material suitable for the conditions. Where practicable, the use of dissimilar metals in contact anywhere in the system shall be avoided to eliminate the possibility of galvanic action.

Note: Meat-packing plants, tanneries, hide cellars, casing rooms, glue houses, fertilizer rooms, salt storage, some chemical works, metal refineries, pulp and paper mills, sugar mills, roundhouses, textile bleacheries, plants producing synthetic staples, some stables, and similar locations are judged to be occupancies where severe corrosive conditions are likely to be present.

E-346.02. Other Chapters.

Installations of rigid metal conduit shall comply with the provisions of the applicable rules of Chapter E-300.

A. Installation

E-346.03. Cinder Fill.

Conduit, unless of corrosion-resistant material suitable for the purpose shall not be used in or under cinder fill where subject to permanent moisture unless protected on all sides by a layer of non-cinder concrete at least 2 inches thick or unless the conduit is at least 18 inches under the fill.

E-346.04. Wet Locations.

(1) In portions of dairies, laundries, canneries, and other wet locations, and in locations where walls are frequently washed, the entire conduit system, including all boxes and fittings used therewith, shall be so installed and equipped as to



prevent water from entering the conduit and the conduit shall be mounted so that there is at least one-quarter inch air space between the conduit and the wall or other supporting surface.

(2) All supports, bolts, straps, screws, etc., shall be of corrosion-resistant materials or protected against corrosion by approved corrosion-resistant materials.

E-346.05. Minimum Size.

No conduit smaller than  $\frac{1}{2}$  inch, electrical trade size, shall be used, except as provided for underplaster extensions in Chapter E-344, and for enclosing the leads of motors as permitted in E-430.145(2).

E-346.06. Number of Conductors in Conduit.

The number of conductors permitted in a single conduit shall be as follows:

(1) New Work:

(a) Where conductors are all the same size, use Tables 1 and 2 of Chapter E-900.

(b) Where conductors are of various sizes to be used in combination, use Tables 3 and 4 of Chapter E-900 and the dimensions of rubber-covered conductors from Table 5 of Chapter E-900.

(c) For bare conductors, use actual areas from Table 8 of Chapter E-900.

(2) Rewiring Existing Conduits: For rewiring existing conduits, the allowable fill may be determined from Tables 3 and 4 of Chapter E-900, using the dimensions from Table 5 of Chapter E-900.

E-346.07. Reaming.

All cut ends of conduits shall be reamed to remove rough edges.

E-346.08. Bushings.

Where a conduit enters a box or other fitting, a bushing shall be provided to protect the wire from abrasion unless the design of the box or fitting is such as to afford equivalent protection. See E-373.06(2) for the protection of conductors at bushings.

E-346.09. Couplings.

(1) Threadless couplings and connectors used with conduit shall be made tight. Where installed in wet places or where buried in masonry, concrete or fill shall be of a type to prevent water from entering the conduit.

(2) Running threads shall not be used on conduit for connection at couplings.

E-346.10. Bends - How Made.

Bends of rigid conduit shall be so made that the conduit will not be injured, and that the internal diameter of the conduit will not be effectively reduced. The radius of the curve of the inner edge of any field bend shall not be less than shown in Table E-346.10.

Table E-346.10

Radius of Conduit Bends

Size of Conduit	Conductors Without Lead Sheath	Conductors With Lead Sheath
1/2 in.	4 in.	6 in.
3/4 in.	5 in.	8 in.
1 in.	6 in.	11 in.
1-1/4 in.	8 in.	14 in.
1-1/2 in.	10 in.	16 in.
2 in.	12 in.	21 in.
2-1/2 in.	15 in.	25 in.
3 in.	18 in.	31 in.
3-1/2 in.	21 in.	36 in.
4 in.	24 in.	40 in.
5 in.	30 in.	50 in.
6 in.	36 in.	61 in.

E-346.11. Bends - Number in One Run.

A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of 4 quarter bends (360 degrees, total), including those bends located immediately at the outlet or fitting.

E-346.12. Boxes and Fittings.

See Chapter E-370.

B. Construction Specifications

E-346.13. General.

Rigid metal conduit shall conform to the following:

(1) Rigid conduit as shipped shall be in standard lengths of 10 feet including coupling, one coupling to be furnished with each length. Each length shall be reamed and threaded on each end.

(2) Steel conduit shall have an interior coating of a character and appearance so as to readily distinguish it from ordinary pipe commonly used for other than electrical purposes.

(3) Non-ferrous conduit of corrosion-resistant material shall have suitable markings.

CHAPTER E-348

ELECTRICAL METALLIC TUBING

E-348.01. Use.

Electrical metallic tubing may be used for both exposed and concealed work. Electrical metallic tubing protected from corrosion solely by enamel shall not be used. Electrical metallic tubing shall not be used (1) where during installation or afterwards, it will be subject to severe physical damage; (2) in cinder concrete or fill where subject to permanent moisture unless protected on all sides by a layer of non-cinder concrete at least 2 inches thick or unless the tubing is at least 18 inches under the fill.

E-348.02. Other Chapters.

Installations of electrical metallic tubing shall comply with the provisions of the applicable rules of Chapter E-300.

A. Installation

E-348.03. Corrosive Fumes.

Where tubing is exposed to corrosive fumes or vapors such as may exist in meat-packing plants, tanneries, hide cellars, casing rooms, glue houses, fertilizer rooms, salt storage, some chemical works, metal refineries, pulp mills, sugar mills, roundhouses, some stables, and similar locations, tubing and fittings of corrosion-resistant material suitable for the conditions shall be used. Where practicable, the use of dissimilar metals throughout the system shall be avoided to eliminate the possibility of galvanic action.

E-348.04. Wet Locations.

(1) In portions of dairies, laundries, canneries, and other wet locations, and in locations where walls are frequently washed, the entire tubing system, including all boxes and fittings used therewith, shall be so installed and equipped as to prevent water from entering the tubing, and the tubing shall be

mounted so that there is at least one-quarter inch air space between the tubing and the wall or other supporting surface.

(2) All supports, bolts, straps, screws, etc., shall be of corrosion-resistant materials or protected against corrosion by approved corrosion-resistant materials.

E-348.05. Minimum and Maximum Sizes.

No tubing smaller than  $\frac{1}{2}$  inch, electrical trade size, shall be used except as provided for underplaster extensions in Chapter E-344 and for enclosing the leads of motors as permitted in E-430.145(2). The maximum size of tubing shall be the 2-inch electrical trade size.

E-348.06. Number of Conductors in Tubing.

One tubing shall not contain more conductors than as provided in E-346.06.

E-348.07. Threads.

Tubing shall not be coupled together nor connected to boxes, fittings, or cabinets by means of threads in the wall of the tubing, except by fittings approved for the purpose. Threads shall not be of the standard pipe thread dimensions.

E-348.08. Couplings and Connectors.

Threadless couplings and connectors used with tubing shall be made up tight, and where buried in masonry, concrete, or fill, or where installed in wet places shall be of a type to prevent water from entering the raceway.

E-348.09. Bends - How Made.

Bends in the tubing shall be so made that the tubing will not be injured and that the internal diameter of the tubing will not be effectively reduced. The radius of the curve of the inner edge of any field bend shall not be less than shown in Table E-346.10.

E-348.10. Bends - Number in One Run.

A run of electrical metallic tubing between outlet and outlet, between fitting and fitting, or between outlet and fitting, shall not contain more than the

equivalent of four quarter bends (360 degrees, total), including those bends located immediately at the outlet or fitting.

E-348.11. Reaming.

All cut ends of electrical metallic tubing shall be reamed to remove rough edges.

E-348.12. Boxes and Fittings.

See Chapter E-370.

B. Construction Specifications

E-348.13. General.

Electrical metallic tubing shall conform to the following:

(1) Cross Section. The tubing, and elbows and bends for use with the tubing, shall have a circular cross-section.

(2) Finish. Tubing shall have such a finish or treatment of outer surfaces as will provide an approved permanent means of readily distinguishing it, after installation, from rigid conduit.

(3) Connectors. Where the tubing is coupled together by threads, the connector shall be so designed as to prevent bending of the tubing at any part of the thread.

CHAPTER E-350

FLEXIBLE METAL CONDUIT

E-350.01. Other Chapters.

Installations of flexible metal conduit shall comply with the provisions of appropriate (or applicable) provisions of Chapter E-300 and with E-334.05, E-334.06, E-334.10, and E-346.05 to E-346.08 inclusive.

E-350.02. Use.

Flexible metal conduit shall not be used (1) in wet locations, unless conductors are of the lead-covered type or of other type specially approved for the conditions; (2) in hoistways, except as provided in E-620.021; (3) in storage-battery rooms; (4) in any hazardous location except as permitted by E-502.04 and E-503.03; nor (5) where rubber-covered conductors are exposed to oil, gasoline, or other materials having a deteriorating effect on rubber.

E-350.03. Minimum Size.

No flexible metal conduit less than one-half inch electrical trade size shall be used except (1) as permitted for underplaster extensions by E-344.02; (2) as permitted for motors by E-430.145(2); and (3) for connection not over 48 inches in length, or longer on approved assemblies, to equipment where the use of one-half inch or larger size flexible metal conduit is not practicable, in which case flexible metal conduit of three-eighth inch electrical trade size may be used.

Table E-350.03

Size AWG	Maximum Number of Conductors in 3/8"		
	Types RF-32, R, RH	Type RW-RHW	Types TF, T, TW, RU, RUF, RUW
18	4	---	8
16	3	---	6
14	3	2	5
12	2	2	4
10	---	---	3

CHAPTER E-351

LIQUID-TIGHT FLEXIBLE  
METAL CONDUIT

E-351.01. Purpose.

Liquid-tight flexible metal conduit is not intended as a general purpose race-way material. The provisions of this Chapter shall apply to a type of flexible conduit having an outer liquid-tight jacket and employed with suitable terminal fittings approved for the purpose.

E-351.02. Use.

The use of this wiring material shall be restricted as follows:

(1) For the connection of motors or portable equipment where flexibility of connection is required.

(2) Liquid-tight flexible metal conduit shall not be used under the following conditions: (a) where subject to physical damage; (b) where in contact with rapidly moving parts; (c) under conditions such that its temperature, with or without enclosed conductors carrying current, is above 60°C (140°F); (d) in any hazardous location, except as described in E-501.04(2), E-502.04 and E-503.03, unless it is specially approved for such use.

E-351.03. Maximum Size.

The maximum size of liquid-tight flexible metal conduit shall not exceed 1 $\frac{1}{4}$  inch electrical trade size.

E-351.04. Conductor Size.

The maximum size of conductor installed in liquid-tight flexible metal conduit shall not exceed the following values:

Trade Size of Conduit	Size of Conductor
3/8 inch	16 Awg
1/2 inch	12 Awg
3/4 inch	8 Awg
1 inch	6 Awg
1-1/4 inch	2 Awg



CHAPTER E-352

SURFACE METAL RACEWAYS

E-352.01. Use.

Surface metal raceway may be installed in dry locations. It shall not be used (1) where concealed, except that metal raceways approved for the purpose may be used for underplaster extensions; (2) where subject to severe physical damage unless approved for the purpose; (3) where the voltage is 300 volts or more between conductors unless the metal has a thickness of not less than .040 inches; (4) where subject to corrosive vapors; (5) in hoistways; nor (6) in any hazardous location.

E-352.02. Other Chapters.

Installations of surface metal raceways shall comply with the applicable provisions of Chapter E-300.

A. Installation

E-352.03. Size of Conductors.

No conductor larger than No. 6 shall be installed in surface metal raceway.

E-352.04. Number of Conductors in Raceways.

The number of conductors installed in any raceway shall be no greater than the number for which the raceway is designed.

E-352.05. Extension Through Walls and Floors.

Except in multi-outlet assemblies, raceways may be extended through dry walls, dry partitions and dry floors, if in unbroken lengths where passing through.

E-352.06. Combination Raceways.

Where combination metal raceways are used both for signal and for lighting and power circuits, the different systems shall be run in separate compartments, identified by sharply contrasting colors of the interior finish, and the same relative position of compartments shall be maintained throughout the premises.

B. Construction Specifications

E-352.07. General.

Surface metal raceways shall be of such construction as will distinguish them from other raceways. Surface metal raceways and their elbows, couplings, and similar fittings shall be so designed that the sections can be electrically and mechanically coupled together, while protecting the wires from abrasion. Holes for screws or bolts inside the raceway shall be so designed that when screws or bolts are in place their heads will be flush with the metal surface.

CHAPTER E-353

METAL MULTI-OUTLET ASSEMBLY

E-353.01. Other Articles.

Installations of metal multi-outlet assembly shall comply with applicable provisions of Chapter E-300. See definition in Chapter E-100.

E-353.02. Use.

Metal multi-outlet assembly may be installed in dry locations. It shall not be installed (1) where concealed, except that the back and sides of metal multi-outlet assembly may be surrounded by the building finish; (2) where subject to severe physical damage unless approved for the purpose; (3) where the voltage is 300 volts or more between conductors unless assembly is of metal having a thickness of not less than .040 inches; (4) where subject to corrosive vapors; (5) in hoistways nor (6) in any hazardous locations.

E-353.03. Metal Multi-Outlet Assembly Through Dry Partitions.

Metal multi-outlet assembly may be extended through (not run within) dry partitions, providing arrangements are made for removing the cap or cover on all exposed portions and no outlet falls within the partitions.

CHAPTER E-354

UNDERFLOOR RACEWAYS

E-354.01. Other Chapters.

Installations of underfloor raceways shall comply with the applicable provisions of Chapter E-300.

E-354.02. Use.

Underfloor raceways may be installed beneath the surface of concrete or other flooring material, or in office occupancies, where laid flush with the concrete floor and covered with linoleum or equivalent floor covering. Open-bottom type of raceways may be installed in concrete fill between the rough and the finished floor only. Underfloor raceways shall not be installed (1) where subject to corrosive vapors nor (2) in any hazardous location.

E-354.03. Covering.

Raceway coverings shall conform to the following:

(1) Raceways Not Over 4 Inches Wide. Half-round raceways not over 4 inches in width, and, except as permitted in (3) of this rule, flat-top raceways not over 4 inches in width, shall have not less than  $3/4$  inches of concrete or wood above the raceway.

(2) Raceways Over 4 Inches in Width or With Less Than  $1/2$  Inch Separation. Flat-top raceways over 4 inches in width or raceways of any width placed less than  $1/2$  inch apart, shall be covered with concrete to a depth of not less than  $1-1/2$  inches.

(3) Raceways Flush With Concrete. In office occupancies, approved metal flat-top raceways if not over 4 inches in width may be laid flush with the concrete floor surface provided they are covered with substantial linoleum not less than  $1/8$  inch in thickness or with equivalent floor covering. Where more than one and not more than three single raceways are each installed flush with the concrete, they

must be (1) contiguous with each other and joined to form a rigid assembly, or (2) spaced not less than  $\frac{1}{2}$  inch apart.

E-354.04. Size of Conductors.

No conductor larger than that for which the raceway is approved shall be installed in underfloor raceways and the largest size conductor allowed shall be 500,000 cm.

E-354.05. Number of Conductors in Raceway.

The combined cross-sectional area of all conductors shall not exceed 40 per cent of the interior area of the raceway; except that where the raceway contains only armored cable or non-metallic sheathed cable, these requirements shall not apply.

E-354.06. Splices and Taps.

Splices or taps shall be made only in junction boxes.

E-354.07. Discontinued Outlets.

When an outlet is discontinued, the conductors supplying the outlet shall be removed from the raceway.

E-354.08. Open-Bottom Raceway - How Laid.

Open-bottom raceways shall be mechanically secured to the concrete pad. Open-bottom raceways shall be laid on a smooth pad of concrete extending at least 1 inch on each side of the raceway and at least 1 inch thick.

Exception No. 1. This thickness may be reduced to  $\frac{1}{4}$  inch where the raceway crosses a run of conduit.

Exception No. 2. That in lieu of a concrete pad, fittings which will protect the conductors from contact with piping, structural steel and other obstructions may be used.

E-354.09. Laid in Straight Lines.

Underfloor raceways shall be laid so that a straight line from the center of one junction box to the center of the next junction box will coincide with the

center line of the raceway system. Raceways shall be firmly held in place to prevent disturbing this alignment during construction.

E-354.10. Markers at Ends.

At every end of line of raceway, a fitting shall be installed extending through the surface of the floor to mark the line of the duct. Where a duct line is interrupted by another duct line, but continues in a straight line beyond, and has junction boxes or outlets on either side of the crossing line, no markers are necessary at the interrupting point.

E-354.11. Dead Ends.

Dead ends of raceways shall be closed.

E-354.12. Low Points.

Where practicable, raceways and their fittings shall be so arranged as to avoid low points that may form traps for water.

E-354.13. Fittings at Angles.

Where raceways are run at other than right angles, special fittings shall be provided, when in the judgment of the administrative authority, these are necessary.

E-354.14. Junction Boxes.

Junction boxes shall be leveled to the floor grade and sealed against the entrance of water. Junction boxes used with metal raceways shall be metal and shall be electrically continuous with the raceways.

E-354.15. Inserts.

Inserts shall be leveled to the floor grade and sealed against the entrance of water. Inserts used with metal raceways shall be metal and shall be electrically continuous with the raceway. Inserts set in or on fiber raceways before the floor is laid shall be mechanically secured to the raceway. Inserts set in fiber raceways after the floor is laid shall be screwed into the raceway. In cutting through the raceway wall and setting inserts, chips and other dirt shall not be allowed to

fall into the raceway, and tools shall be used which are so designed as to prevent the tool from entering the raceway and injuring conductors that may be in place.

E-354.16. Connections to Cabinets and Wall Outlets.

Connections between raceways and distribution centers and wall outlets shall be made by means of rigid or flexible metal conduit or by means of fittings specially approved for the purpose.

E-354.17. Boxes and Fittings.

See Chapter E-370.

CHAPTER E-356

CELLULAR METAL FLOOR RACEWAYS

E-356.01. Definitions.

For the purposes of this Chapter, a "cellular metal floor raceway" shall be defined as the hollow spaces of cellular metal floors, together with suitable fittings, which may be approved as enclosures for electrical conductors; a "cell" shall be defined as a single, enclosed tubular space in a cellular metal floor member, the axis of the cell being parallel to the axis of the metal floor member; a "header" shall be defined as a transverse raceway for electrical conductors, providing access to predetermined cells of a cellular metal floor, thereby permitting the installation of electrical conductors from a distribution center to the cells.

E-356.02. Use.

Conductors shall not be installed in cellular metal floor raceways (1) where subject to corrosive vapor; (2) in any hazardous location; nor (3) in commercial garages, except for supplying ceiling outlets or extensions to the area below the floor but not above. No electric conductors shall be installed in any cell or header which contains a pipe for steam, water, air, gas, drainage, or other service than electrical.

E-356.03. Other Chapters.

Installations of conductors in the raceways of cellular metal floor shall comply with the applicable provisions of Chapter E-300.

A. Installation

E-356.04. Size of Conductors.

No conductor larger than No. 0 shall be installed, except by special permission.

E-356.05. Number of Conductors in Raceway.

The combined cross-sectional area of all conductors shall not exceed 40 per cent of the interior area of the header feeding the individual cells; except that where the raceway contains only armored cable or non-metallic sheathed cable, these requirements shall not apply.

E-356.06. Splices and Taps.

Splices and taps shall be made only in header access units or junction boxes.

E-356.07. Discontinued Outlets.

When an outlet is discontinued, the conductors supplying the outlet shall be removed from the raceway.

E-356.08. Markers.

A suitable number of markers shall be installed extending through the floor for the future locating of cells and for system identification.

E-356.09. Junction Boxes.

Junction boxes shall be levelled to the floor grade and sealed against the entrance of water. Junction boxes used with these raceways shall be of metal and shall be electrically continuous with the raceway.

E-356.10. Inserts.

Inserts shall be levelled to the floor grade and sealed against the entrance of water. Inserts shall be of metal and shall be electrically continuous with the raceway. In cutting through the cell wall and setting inserts, chips and other dirt shall not be allowed to fall into the raceway, and tools shall be used which are designed to prevent the tool from entering the cell and injuring the conductors.

E-356.11. Connection to Cabinets and Extensions from Cells.

Connections to cabinets and extensions from cells to outlets shall be made by means of rigid or flexible conduit or by means of fittings approved for the purpose.

B. Construction Specifications

E-356.12. General.

Cellular metal floor raceways shall be so constructed that adequate electrical



and mechanical continuity of the complete system will be secured. They shall provide a complete enclosure for the conductors. The interior surfaces shall be free from burrs and sharp edges, and surfaces over which conductors are drawn shall be smooth. Suitable bushings or fittings having smooth rounded edges shall be provided where conductors pass.

CHAPTER E-358

CELLULAR CONCRETE FLOOR RACEWAYS

E-358.01. Scope.

Precast cellular concrete floor raceways shall comply with the applicable requirements of Chapter E-300, and shall also comply with the provisions of E-358.02 to E-358.11 inclusive. For the purpose of this Chapter, "precast cellular concrete floor raceways" shall be defined as the hollow spaces in floors constructed of precast cellular concrete slabs, together with suitable metal fittings designed to provide access to the floor cells in an approved manner. A "cell" shall be defined as a single, enclosed tubular space in a floor made of precast cellular concrete slabs, the direction of the cell being parallel to the direction of the floor member. "Header ducts" shall be defined as transverse metal raceways for electrical conductors, furnishing access to predetermined cells of a precast cellular concrete floor, thus providing for the installation of electrical conductors from a distribution center to the floor cells.

E-358.02. Use.

Conductors shall not be installed in precast cellular concrete floor raceways (1) where subject to corrosive vapor; (2) in hazardous locations; nor (3) in commercial garages, except for supplying ceiling outlets or extensions to the area below the floor but not above. No electrical conductor shall be installed in any cell or header which contains a pipe for steam, water, air, gas, drainage, or any service other than electrical.

E-358.03. Header Duct.

The header duct shall be installed in a straight line, at right angles to the cells. The header duct shall be mechanically secured to the top of the precast cellular concrete floor. The end joints shall be closed by metallic closure fittings and sealed against the penetration of water. The header duct shall be electrically continuous throughout its entire length and shall be electrically bonded

to the enclosure of the distribution center.

E-358.04. Connection to Cabinets and Other Enclosures.

Connection from header duct to cabinets and other enclosures shall be made by means of metallic duct and fittings approved for the purpose.

E-358.05. Junction Boxes.

Junction boxes shall be levelled to the floor grade and sealed against the entrance of water. Junction boxes shall be of metal and shall be mechanically and electrically continuous with the header ducts.

E-358.06. Markers.

Each hidden access point between a header and a cell intended for future use shall be provided with a marker extending through the floor covering. A suitable number of markers shall be installed, extending through the floor covering, to locate the cells and to provide system identification.

E-358.07. Inserts.

Inserts shall be levelled to the floor grade and sealed against the entrance of water. Inserts shall be of metal and shall be fitted with receptacles of the grounded type. A ground conductor shall connect the insert receptacles to a positive ground connection provided on the header duct. In cutting through the cell wall for setting inserts or other purposes (such as providing access openings between header duct and cells) chips and other dirt shall not be allowed to fall into the raceway, and the tool used shall be so designed as to prevent the tool from entering the cell and injuring the conductors.

E-358.08. Size of Conductors.

No conductor larger than No. 0 shall be installed, except by special permission.

E-358.09. Number of Conductors in Raceway.

The combined cross-sectional area of all conductors in any header shall not exceed 40 per cent of the interior cross-sectional area of such header; except that

where the header contains only armored cable or non-metallic sheathed cable, or both, this limitation shall not apply.

E-358.10. Splices and Taps.

Splices and taps shall be made only in header duct access units or junction boxes.

E-358.11. Discontinued Outlets.

When an outlet is discontinued, the conductors supplying the outlet shall be removed from the header and cell.

CHAPTER E-362

WIREWAYS

E-362.01. Definition.

Wireways are sheet-metal troughs with hinged or removable covers for housing and protecting electrical wires and cable and in which conductors are laid in place after the wireway has been installed as a complete system.

E-362.02. Use.

Wireways may be installed only for exposed work. Wireways intended for outdoor use shall be of approved raintight construction. Wireways shall not be installed: (1) where subject to severe physical damage or corrosive vapor; nor (2) in any hazardous location.

E-362.03. Other Chapters.

Installations of wireways shall comply with the applicable provisions of Chapter E-300.

E-362.04. Size of Conductors.

No conductor larger than 500,000 c.m. shall be installed in any wireway.

E-362.05. Number of Conductors.

(1) Wireways shall not contain more than 30 conductors at any cross section, unless the conductors are for signaling circuits or are control conductors between a motor and its starter and used only for starting duty. The sum of the cross-sectional areas of all contained conductors at any cross-section of a wireway shall not exceed 20 per cent of the interior cross-sectional area of the wireway.

(2) The correction factors specified in Note 8 of Tables E-310.12 and E-310.14 are not applicable to the foregoing.

E-362.06. Splices and Taps.

Splices or taps, made and insulated by approved methods, may be located within the wireway provided they are accessible. The conductors, including splices and

taps, shall not fill the wireway to more than 75 per cent of its area at that point.

E-362.07. Supports.

Wireways shall be securely supported at intervals not exceeding 5 feet, unless specially approved for supports at greater intervals, but in no case shall the distance between supports exceed 10 feet.

E-362.08. Extension Through Walls.

Wireways may extend transversely through dry walls if in unbroken lengths where passing through.

E-362.09. Dead-Ends.

Dead-ends of wireways shall be closed.

E-362.10. Extensions From Wireways.

Extensions from wireways shall be made with rigid or flexible metal conduit, electrical metallic tubing, surface metal raceway or armored cable.

E-362.11. Marking.

Wireways shall be marked so that their manufacturer's name or trade mark will be visible after installation.

CHAPTER E-364

BUSWAYS

E-364.01. Other Chapters.

Installations of busways shall comply with the applicable provisions of Chapter E-300.

E-364.02. Use.

Busways may be installed only for exposed work. Busways shall not be installed (1) where subject to severe physical damage or corrosive vapors; (2) in hoistways; (3) in any hazardous location; nor (4) outdoors or in wet or damp locations unless specially approved for the purpose.

Note 1. Busways may be used for service-entrance conductors. See E-230.044.

Note 2. It is recommended that where secondary systems are operated ungrounded, a combination ground detector and potentializer plug be used as an auxiliary fitting for busway systems to establish a definite potential difference between the bus-bars and the grounded casing of the busways. This will serve to drain off any static or other charge from the entire busway system including its connected apparatus, supply and branch circuit conductors.

E-364.03. Support.

Busways shall be securely supported at intervals not exceeding 5 feet, unless specially approved for supports at greater intervals, but in no case shall the distance between supports exceed 10 feet. Where a busway is installed in a vertical position, the supports for the bus-bars shall be designed for vertical installation.

E-364.04. Extension Through Walls.

Busways may extend transversely through dry walls if in unbroken lengths where passing through. Busways may extend vertically through dry floors when totally enclosed (unventilated) where passing through and for a minimum distance of six feet above the floor to provide adequate protection from physical damage.

E-364.05. Dead-Ends.

A dead-end of a busway shall be closed.

E-364.07. Branches from Busways.

Branches from busways shall be made with busways or with rigid or flexible metal conduit, electrical metallic tubing, surface metal raceway, armored cable or with suitable cord assemblies approved for hard usage for portable equipment or for the connection of stationary equipment to facilitate their interchange.

E-364.08. Overcurrent Protection.

Overcurrent protection shall be provided in accordance with E-364.09 to E-364.13 inclusive.

E-364.09. Rating of Overcurrent Protection - Feeders and Sub-Feeders.

Where the allowable current rating of the busway does not correspond to a standard rating of the overcurrent device, the next higher rating may be used.

E-364.10. Reduction in Size of Busway.

Overcurrent protection may be omitted at points where busways are reduced in size, provided that the smaller busway does not extend more than 50 feet and has a current rating at least equal to one-third the rating or setting of the overcurrent device next back on the line, and provided further that such busway is free from contact with combustible material.

E-364.11. Branch Circuits.

Where a busway is used as a feeder, devices or plug-in connections for tapping off branch-circuits from the busway shall contain the overcurrent devices required for the protection of the branch circuits.

Exception No. 1. For overcurrent protection of taps, see E-240.15.

Exception No. 2. For fixed or semi-fixed lighting fixtures, the branch circuit overcurrent device may be part of the fixture cord plug on cord-connected fixtures.

Exception No. 3. Where fixtures without cords are plugged directly into the



busway, the overcurrent device may be mounted on the fixture.

E-364.12. Rating of Overcurrent Protection - Branch Circuits.

A busway may be used as a branch circuit of any one of the types described in Chapter E-210. When so used, the rating or setting of the overcurrent device protecting the busway shall determine the ampere rating of the branch circuit, and the circuit shall in all respects conform with the requirements of Chapter E-210 that apply to branch circuits of that rating.

E-364.13. Length of Busways Used as Branch Circuits.

Busways which are used as branch circuits and which are so designed that loads can be connected at any point shall be limited to such lengths as will provide that in normal use the circuits will not be overloaded.

Note: In general, the length of such run in feet should not exceed three times the ampere rating of the branch circuit.

E-364.14. Marking.

Busways shall be marked with the voltage and current rating for which they are designed, and with the manufacturer's name or trademark in such manner as to be visible after installation.

CHAPTER E-370

OUTLET, SWITCH AND JUNCTION BOXES, AND FITTINGS

A. Scope and General

E-370.01. Scope.

The provisions of this Chapter shall apply to the installation of outlet, switch and junction boxes, and fittings as required by E-300.15. Installations in hazardous locations shall conform to Chapters E-500 to E-517 inclusive.

E-370.02. Round Boxes.

Round boxes shall not be used where conduits or connectors requiring the use of locknuts or bushings are to be connected to the side of the box.

E-370.03. Non-Metallic Boxes.

Non-metallic boxes may be used only with open wiring on insulators, concealed knob-and-tube work, non-metallic sheathed cable, and with non-metallic waterproof wiring.

E-370.04. Metallic Boxes.

Where used with knob-and-tube work or non-metallic sheathed cable, and mounted on metal or metal lath ceilings or walls, such boxes shall be insulated from their supports and from the metal or metal lath, or shall be grounded.

B. Installation

E-370.05. Damp or Wet Locations.

In damp or wet locations, boxes and fittings shall be so placed or equipped as to prevent moisture or water from entering and accumulating within the box or fitting. Boxes and fittings installed in wet locations shall be weatherproof. For boxes in floors, see E-410.53.

Note: It is recommended that boxes of non-conductive material be used with non-metallic sheathed cable when such cable is used in locations where there is likely to be occasional moisture present such as in dairy barns.

E-370.06. Number of Conductors in a Box.

Boxes shall be of sufficient size to provide free space for all conductors enclosed in the box. The limitations in E-370.06 (1) and (2) shall not apply to terminal housings supplied with motors, nor to types of boxes or fittings without knockout and having hubs or recessed parts for terminal bushings and locknuts.

Note: E-370.06 (1) and (2) do not apply to conductors used for rewiring existing raceways as referred to in Table 3, Chapter E-900.

(1) The maximum number of conductors, not counting fixture wires, permitted in outlet and junction boxes shall be as in Tables E-370.06 (1) (2) and (b).

Table E-370.06 (1)(a) - Deep Boxes

Box Dimensions, Inches Trade Size	Maximum Number of Conductors			
	No. 14	No. 12	No. 10	No. 8
1½ x 3¼ octagonal . . . . .	5	5	4	0
1½ x 4 octagonal . . . . .	8	7	6	5
1¼ x 4 square . . . . .	9	7	6	4
1½ x 4 square . . . . .	11	9	7	5
1½ x 4 11/16 square . . . . .	16	12	10	8
2 1/8 x 4 11/16 square . . . . .	20	16	12	10
2 x 1 3/4 x 2 3/4 . . . . .	5	4	4	
2½ x 1 3/4 x 2 3/4 . . . . .	6	6	5	
3 x 1 3/4 x 2 3/4 . . . . .	7	7	6	

Note: Where there is not sufficient space for a deeper box, four No. 14 AWG conductors may enter a box provided with cable clamps and containing one or more devices on a single mounting strap.

Table E-370.06 (1) (b) - Shallow Boxes  
of Less than 1½ Inches Depth

Box Dimensions, Inches Trade Size	Maximum Number of Conductors		
	No. 14	No. 12	No. 10
3¼ . . . . .	4	4	3
4 . . . . .	6	6	4
4 11/16 . . . . .	8	6	6

Note: Tables E-370.06 (1)(a) and (b) apply where no fittings or devices, such

as fixture studs, cable clamps, hickkeys, switches or receptacles are contained in the box. Where one or more fixture studs, cable clamps, or hickkeys are contained in the box, the number of conductors shall be one less than shown in the Tables, with a further deduction of one conductor for one or several flush devices mounted on the same strap. A conductor running through the box is counted as one conductor and each conductor originating outside the box and terminating inside the box is counted as one conductor. Conductors of which no part leaves the box are not to be counted in the above computation. If single flush boxes are ganged, and each section is occupied by a flush device or combination of flush devices on the same strap, the limitations will apply to each section individually.

(2) For combinations not shown in the above Tables the following Table shall apply.

Table E-370.06 (2)

Size of Conductor	Free Space Within Box for Each Conductor
No. 14 . . . . .	2. cubic inches
No. 12 . . . . .	2.25 cubic inches
No. 10 . . . . .	2.5 cubic inches
No. 8 . . . . .	3. cubic inches

E-370.07. Conductors Entering Boxes or Fittings.

Conductors entering boxes or fitting shall be protected from abrasion and shall conform to the following:

(1) Openings to Be Closed. Openings through which conductors enter shall be adequately closed.

(2) Metal Boxes and Fittings. Where metal outlet boxes or fittings are installed with open wiring or concealed knob-and-tube work, conductors shall enter through insulating bushings or, in dry places, through flexible tubing extending from the last insulating support and firmly secured to the box or fitting. Where raceway or cable is installed with metal outlet boxes or fittings, the raceway or

cable shall be secured to such boxes and fittings.

(3) Non-Metallic Boxes. Where non-metallic boxes are used with open wiring or concealed knob-and-tube work, the conductors shall enter through individual holes. Where flexible tubing is used to encase the conductor, the tubing shall extend from the last insulating support and may be run into the box or terminate at the wall of the box. If non-metallic sheathed cable is used, the cable assembly shall enter the box through a knockout opening. Clamping of individual conductors or cables to the box is not required where supported within 8 inches of the box.

E-370.08. Unused Openings.

Unused openings in boxes and fittings shall be effectively closed to afford protection substantially equivalent to that of the wall of the box or fitting. Metal plugs or plates used with non-metallic boxes or fittings shall be recessed at least  $\frac{1}{4}$  inch from the outer surface.

E-370.09. Boxes Enclosing Flush Devices.

Boxes used to enclose flush devices shall be of such design that the devices will be completely enclosed on back and sides, and that substantial support for the devices will be provided. Screws for supporting the box shall not be used in attachment of the device contained therein.

E-370.10. In Wall or Ceiling.

In walls or ceilings of concrete, tile or other noncombustible material, boxes and fittings shall be so installed that the front edge of the box or fitting will not set back of the finished surface more than  $\frac{1}{4}$  inch. In walls and ceilings constructed of wood or other combustible material, outlet boxes and fittings shall be flush with the finished surface or project therefrom.

E-370.11. Repairing Plaster.

Except on walls or ceilings of concrete, tile or other noncombustible material, a plaster surface which is broken or incomplete shall be repaired so that there will be no gaps or open spaces at the edge of the box or fitting.

E-370.12. Exposed Extensions.

In making an exposed extension from an existing outlet of concealed wiring, a box, extension ring or blank cover shall be mounted over the original box and electrically and mechanically secured to it. The extension shall then be connected to this box in the manner prescribed for the method of wiring employed in making the extension.

E-370.13. Supports.

(1) General. Boxes, fittings and cabinets shall be securely fastened in place. Boxes and fittings, not over 100 cubic inches in size, which are attached to firmly secured exposed raceway by threading or other connection designed for the purpose, are considered as so fastened.

(2) Concealed Work. In concealed work, except as prescribed in E-370.13(3), boxes and fittings, unless securely held in place by concrete, masonry or other building material in which they are embedded, shall be secured to a stud, joist or similar fixed structural unit, or to a metal or wooden support which is secured to such a structural unit. Wooden supports shall be not less than  $\frac{7}{8}$  inch in thickness. Lath of wood, metal or composition shall not be considered a structural unit. See E-410.15 and E-410.16 for support of fixtures.

(3) Exposed Work. In exposed work, and in concealed work in existing buildings where conductors or cables are fished and boxes cannot be secured as provided in E-370.13(2) without disturbing the building finish, the boxes may be mounted directly upon the plaster surface when securely fastened in place.

E-370.14. Depth of Outlet Boxes for Concealed Work.

Outlet boxes for concealed work shall have an internal depth of at least  $1\frac{1}{2}$  inches, except that where the installation of such a box will result in injury to the building structure or is impracticable, a box not less than  $\frac{1}{2}$  inch internal depth may be installed.

E-370.15. Covers and Canopies.

In completed installations each outlet box shall be provided with a cover

unless a fixture canopy is used.

(1) Non-metallic covers and plates may be used with non-metallic outlet boxes. When metal covers or plates are used, they are subject to the grounding requirements of E-250.042.

(2) Where a fixture canopy or pan is used, any combustible wall or ceiling finish exposed between the edge of the canopy or pan and the outlet box shall be covered with non-combustible material.

(3) Covers of outlet boxes having holes through which flexible cord pendants pass, shall be provided with bushings designed for the purpose or shall have smooth, well-rounded surfaces on which the cords may bear. So-called hard-rubber or composition bushings shall not be used.

E-370.16. Fastened to Gas Pipes.

Outlet boxes used where gas outlets are present shall be so fastened to the gas pipes as to be mechanically secure.

E-370.17. Boxes at Lighting Fixture Outlets.

Boxes used at outlets for lighting fixtures shall be designed for the purpose. At every outlet used exclusively for lighting, the box shall be so designed or installed that a lighting fixture may be attached.

E-370.18. Pull and Junction Boxes.

Pull and junction boxes shall conform to the following:

(1) Minimum Size. For raceways of  $1\frac{1}{4}$  inch trade size and larger, containing conductors of No. 6 or larger, the minimum dimensions of a pull box or a junction box installed in a raceway shall conform to the following:

(a) Straight Pulls. In straight pulls the length of the box shall be not less than 8 times the trade diameter of the largest raceway.

(b) Angle or U Pulls. Where angle or U pulls are made, the distance between each raceway entry inside the box and the opposite wall of the box shall not be less than 6 times the trade diameter of the raceway. This distance shall be

increased for additional entries by the amount of the sum of the diameters of all other raceway entries on the same wall of the box. The distance between raceway entries enclosing the same conductor shall not be less than 6 times the trade diameter of the larger raceway.

Exception. The limitations of E-370.18 (1)(a) and (1)(b) are not intended to apply to terminal housings supplied with motors, nor to types of boxes or fittings without knockouts and having hubs or recessed parts for terminal bushings and locknuts.

(2) Conductors in Pull or Junction Boxes. In pull boxes or junction boxes having any dimension over 6 feet, all conductors shall be cabled or racked up in an approved manner.

Note: See E-373.06(2) for insulation of conductors at bushings.

E-370.19. Junction Boxes Be Accessible.

Junction boxes shall be so installed that the wiring contained in them may be rendered accessible without removing any part of the building, sidewalks or paving.

C. Construction Specifications

E-370.20. Metallic Outlet, Switch and Junction Boxes and Fittings.

Outlet, switch and junction boxes and fittings, when of metal, shall conform to the following:

(1) Corrosion-Resistant. Metallic boxes and fittings, unless of corrosion-resistant metal, shall be well galvanized, enameled, or otherwise properly coated, inside and out, to prevent corrosion.

Note 1. See E-300.05 for limitation in the use of boxes and fittings protected from corrosion solely by enamel.

Note 2. It is recommended that the protective coating be of conductive material, such as cadmium, tin or zinc, in order to secure better electrical contact.

(2) Thickness of Metal. For sheet steel boxes and fittings not over 100 cubic inches in size, the metal shall not be less than No. 14 MS (USS revised)



gauge in thickness. Cast metal boxes shall have a wall thickness of not less than 1/8 inch, except that boxes of malleable iron shall have a wall thickness of not less than 3/32 inch.

(3) Boxes Over 100 Cubic Inches. Boxes of over 100 cubic inches in size shall be composed of metal and shall conform to the requirements for cabinets and cutout boxes, except that the covers may consist of single flat sheets secured to the box proper by screws, or bolts instead of hinges. Boxes having covers of this form are for use only for enclosing joints in conductors or to facilitate the drawing in of wires and cables. They are not intended to enclose switches, cut-outs or other control devices.

E-370.21. Covers.

Metal covers shall be of a thickness not less than that specified for the walls of the box or fitting of the same material and with which they are designed to be used, or shall be lined with firmly attached insulating material not less than 1/32 inch in thickness. Covers of porcelain or other approved insulating material may be used when of such form and thickness as to afford the requisite protection and strength.

E-370.22. Bushings.

Covers of outlet boxes and outlet fittings having holes through which flexible cord pendants may pass, shall be provided with approved bushings or shall have smooth, well-rounded surfaces, upon which the cord may bear. Where conductors other than flexible cord may pass through a metal cover, there shall be provided a separate hole for each wire, said hole being equipped with a bushing of suitable insulating material.

E-370.23. Non-Metallic Boxes.

Provisions for supports, or other mounting means, for non-metallic boxes, shall be outside of the box, or the box shall be so constructed as to prevent contact between the conductors in the box and the supporting screws.

CHAPTER E-373

CABINETS AND CUTOUT BOXES

E-373.01. Scope.

The provisions of this Chapter shall apply to the installation of cabinets and cutout boxes. Installations in hazardous locations shall conform to the provisions of Chapters E-500 to E-517 inclusive.

A. Installation

E-373.02. Damp or Wet Locations.

In damp or wet locations, cabinets and cutout boxes of the surface type shall be so placed or equipped as to prevent moisture or water from entering and accumulating within the cabinet or cutout box, and shall be mounted so there is at least one-quarter inch air space between the enclosure and the wall or other supporting surface. Cabinets or cutout boxes installed in wet locations shall be weatherproof.

Note: It is recommended that boxes of non-conductive material be used with non-metallic sheathed cable when such cable is used in locations where there is likely to be moisture present.

E-373.03. Position in Wall.

In walls of concrete, tile, or other noncombustible material, cabinets shall be so installed that the front edge of the cabinet will not set back of the finished surface more than  $\frac{1}{4}$  inch. In walls constructed of wood or other combustible material, cabinets shall be flush with the finished surface or project therefrom.

E-373.04. Unused Openings.

Unused openings in cabinet or cutout boxes shall be effectively closed to afford protection substantially equivalent to that of the wall of the cabinet or cutout box. Where metal plugs or plates are used with non-metallic cabinets or cutout boxes, they shall be recessed at least  $\frac{1}{4}$  inch from the outer surface.

E-373.05. Conductors Entering Cabinets or Cutout Boxes.

Conductors entering cabinets or cutout boxes shall be protected from abrasion

and shall conform to the following:

(1) Openings to Be Closed. Openings through which conductors enter shall be adequately closed.

(2) Metal Cabinets and Cutout Boxes. Where metal cabinets or cutout boxes are installed with open wiring or concealed knob-and-tube work, conductors shall enter through insulating bushings or, in dry places, through flexible tubing extending from the last insulating support and firmly secured to the cabinet or cutout box.

E-373.06. Deflection of Conductors.

Conductors entering or leaving cabinets or cutout boxes and the like shall conform to the following:

(1) Width of Gutters. Vertical conductors No. 1 or larger shall not be deflected where they enter or leave a cabinet unless a gutter having a width in accordance with the following Table is provided:

Table E-373.06 (1) - Width of Gutters

Conductor Size	Minimum Width of Gutter in Inches
No. 1 . . . . .	3
0 to 00 . . . . .	3½
000 to 0000 . . . . .	4
250,000 c.m. . . . .	4½
300,000 to 350,000 c.m. . . . .	5
400,000 to 500,000 c.m. . . . .	6
600,000 to 900,000 c.m. . . . .	8
1,000,000 to 1,250,000 c.m. . . . .	10
1,500,000 to 2,000,000 c.m. . . . .	12

(2) Insulation at Bushings. Where ungrounded conductors of No. 4 or larger enter a raceway in a cabinet, pull box, junction box, or auxiliary gutter, the conductors shall be protected by a substantial bushing providing a smoothly rounded insulating surface, unless the conductors are separated from the raceway fitting by substantial insulating material securely fastened in place. Where conduit bushings are constructed wholly of insulating material, a locknut shall be

installed both inside and outside the enclosure to which the conduit is attached.

E-373.07. Space in Enclosures.

Cabinets and cutout boxes shall be selected which have sufficient space to accommodate all conductors installed in them without crowding.

E-373.08. Switch Enclosures.

Switch enclosures shall not be used as junction boxes, troughs or raceways for conductors feeding through or tapping off to other switches, unless designs suitable for the purpose are employed to provide adequate space for this purpose.

E-373.09. Side or Back Wiring Spaces or Gutters.

Cabinets and cutout boxes shall be provided with back wiring spaces, gutters, or wiring compartments as required by E-373.11 (3) and (4).

B. Construction Specifications

E-373.10. Material.

Cabinets and cutout boxes shall conform to the following:

(1) Metal Cabinets and Boxes. Metal cabinets and cutout boxes shall be well galvanized, plated with cadmium or other approved metallic finish, enameled, or otherwise properly coated, inside and out, to prevent corrosion.

Note: It is recommended that the protective coating be of conductive material, such as cadmium, tin or zinc, in order to secure better electrical contact.

(2) Strength. The design and construction of cabinets and cutout boxes shall be such as to secure ample strength and rigidity. If constructed of sheet steel, the metal shall be of not less than No. 16 MS (USS revised) gauge in thickness.

(3) Composition Cabinets. Composition cabinets shall be submitted for approval prior to installation.

E-373.11. Spacing.

The spacing within cabinets and cutout boxes shall conform to the following:

(1) General. The spacing within cabinets and cutout boxes shall be sufficient to provide ample room for the distribution of wires and cables placed in them,

and for a separation between metal parts of devices and apparatus mounted within them as follows:

(a) Base. There shall be an air space of at least 1/16 inch, except at points of support, between the base of the device and the wall of any metal cabinet or cutout box in which the device is mounted.

Doors.

(b) There shall be an air space of at least 1 inch between any live metal part (including live metal parts of enclosed fuses) and the door, unless the door is lined with an approved insulating material or is of a thickness of metal not less than No. 12 MS (USS revised) gauge in thickness, when the air space shall be not less than  $\frac{1}{2}$  inch.

(c) Doors and Walls - Link Fuses. There shall be a space of at least 2 inches between open link fuses and metal-lined walls or metal, metal-lined or glass-paneled doors.

(d) Live Parts. Except as noted above, there shall be an air space of at least  $\frac{1}{2}$  inch between the walls, back, gutter partition, if of metal, or door of any cabinet or cutout box and the nearest exposed current-carrying part of devices mounted within the cabinet where the potentials do not exceed 250 volts. This spacing shall be increased to at least one inch where the potentials exceed 250 volts.

(2) Switch Clearance. Cabinets and cutout boxes shall be deep enough to allow the closing of the doors when 30-ampere branch-circuit panelboard switches are in any position, or when combination cutout switches are in any position, or when other single-throw switches are opened as far as their construction will permit.

(3) Wiring Space. Cabinets and cutout boxes which contain devices or apparatus connected within the cabinet or box to more than 8 conductors, including those of branch circuits, meter loops, sub-feeder circuits, power circuits and similar circuits, but not including the supply circuit or a continuation thereof,

shall have back wiring spaces or one or more side wiring spaces, side gutters or wiring compartments.

(4) Wiring Space - Enclosure. Side wiring spaces, side gutters or side wiring compartments of cabinets and cutout boxes shall be rendered tight enclosures by means of covers, barriers or partitions extending from the bases of the devices, contained in the cabinet, to the door, frame, or sides of the cabinet; provided, however, that where the enclosure contains only those conductors which are led from the cabinet at points directly opposite their terminal connections to devices within the cabinet, such covers, barriers or partitions may be omitted. Partially enclosed back wiring spaces shall be provided with covers to complete enclosure. Wiring spaces that are required by E-373.11 (3) and which are exposed when doors are open, shall be provided with covers to complete the enclosure.

CHAPTER E-374

AUXILIARY GUTTERS

E-374.01. Purpose.

Auxiliary gutters, used to supplement wiring spaces at meter centers, distribution centers, switchboards and similar points of wiring systems, may enclose conductors or bus-bars, but shall not be used to enclose switches, overcurrent devices or other appliances or apparatus.

E-374.02. Extension Beyond Equipment.

An auxiliary gutter shall not extend a greater distance than 30 feet beyond the equipment which it supplements except in elevator work. Any extension beyond this distance shall comply with the provisions for wireways in Chapter E-362 or with the provisions for busways in Chapter E-364.

E-374.03. Supports.

Gutters shall be supported throughout their entire length at intervals not exceeding 5 feet.

E-374.04. Covers.

Covers shall be securely fastened to the gutter.

E-374.05. Number of Conductors.

(1) Auxiliary gutters shall not contain more than 30 conductors at any cross section unless the conductors are for signalling circuits or are control conductors between a motor and its starter and used only for starting duty. The sum of the cross-sectional areas of all contained conductors at any cross section of an auxiliary gutter shall not exceed 20 per cent of the interior cross-sectional area of the gutter.

(2) The correction factors specified in Note 8 of Tables E-310.12 and E-310.14 are not applicable to the foregoing.

Note: For elevators see E-620.35.

E-374.06. Carrying Capacity of Copper Bars.

The current carried continuously in bare conductors in auxiliary gutters shall not exceed 1000 amperes per square inch of cross section of the conductor.

E-374.07. Clearance of Bare Live Parts.

Bare conductors shall be securely and rigidly supported so that the minimum clearance between bare current-carrying metal parts of opposite polarities mounted on the same surface shall be not less than 2 inches, nor less than 1 inch for parts that are held free in the air. A clearance not less than 1 inch shall be secured between bare current-carrying metal parts and any metal surface. Adequate provision shall be made for expansion and contraction of copper bars.

E-374.08. Splices and Taps.

Splices and taps shall conform to the following:

(1) Splices or taps, made and insulated by approved methods, may be located within gutters when they are accessible by means of removable covers or doors. The conductors, including splices and taps, shall not fill the gutter to more than 75 per cent of its area.

(2) Taps from bare conductors shall leave the gutter opposite their terminal connections and conductors shall not be brought in contact with uninsulated current-carrying parts of opposite polarity.

(3) All taps shall be suitably identified at the gutter as to the circuit or equipment which they supply.

(4) Tap connections from conductors in auxiliary gutters shall be provided with overcurrent protection in conformity with the provisions of E-240.15.

E-374.09. Construction and Installation.

Auxiliary gutters shall be constructed in accordance with the following:

(1) Gutters shall be so constructed and installed that adequate electrical and mechanical continuity of the complete system will be secured.

(2) Gutters shall be of substantial construction and shall provide a complete enclosure for the contained conductors. All surfaces, both interior and



exterior, shall be suitably protected from corrosion. Corner joints shall be made tight and where the assembly is held together by rivets or bolts, these shall be spaced not more than 12 inches apart.

(3) Suitable bushings, shields or fittings having smooth rounded edges shall be provided where conductors pass between gutters, through partitions, around bends, between gutters and cabinets or junction boxes and at other locations where necessary to prevent abrasion of the insulation of the conductors.

(4) Gutters shall be constructed of sheet metal of thicknesses not less than in the following table:

Table E-374.09(4)

Maximum Width of the Widest Surface of Gutters  
Thickness in MS (USS revised) Gauge

Up to and including 6 inches . . . . .	No. 16
Over 6 inches and not over 18 inches . . . . .	No. 14
Over 18 inches and not over 30 inches . . . . .	No. 12
Over 30 inches . . . . .	No. 10

(5) Where insulated conductors are deflected within the auxiliary gutter, either at the ends or where conduits, fittings or other raceways enter or leave the gutter, or where the direction of the gutter is deflected greater than 30 degrees, dimensions corresponding to E-373.06 shall apply.

(6) Auxiliary gutters intended for outdoor use shall be of approved raintight construction.

CHAPTER E-380

SWITCHES

A. Installation

E-380.01. Grounded Conductors.

No switch or circuit-breaker shall disconnect the grounded conductor of a circuit unless the switch or circuit-breaker simultaneously disconnects the ungrounded conductor or conductors, or unless the switch or circuit-breaker is so arranged that the grounded conductor cannot be disconnected until the ungrounded conductor or conductors have first been disconnected.

E-380.02. Three-Way and Four-Way Switches.

Three-way and four-way switches shall be so wired that all switching is done only in the ungrounded circuit conductor. Wiring between switches and outlets shall, where in metal enclosures, be run with both polarities in the same enclosure.

E-380.03. Enclosures.

Switches and circuit-breakers shall be of the externally operable type enclosed in metal boxes or cabinets, except pendent and surface type snap switches and knife switches mounted on an open face switchboard or panelboard.

E-380.04. Wet Locations.

A switch or circuit-breaker in a wet location or outside of a building shall be enclosed in a weatherproof enclosure or cabinet installed to conform to

E-373.02.

E-380.05. Time Switches, Flashers, and Similar Devices.

Time switches, flashers, and similar devices need not be of the externally operable type. They shall be enclosed in metal boxes or cabinets except:

Exception No. 1. Where mounted on switchboards or control panels.

Exception No. 2. Where enclosed in approved individual housings.

E-380.06. Position of Knife Switches.

Single-throw knife switches shall be so placed that gravity will not tend to close them. Double-throw knife switches may be mounted so that the throw will be either vertical or horizontal as preferred, but where the throw be vertical a locking device shall be provided which will insure the blades remaining in the open position when so set.

E-380.07. Connection of Knife Switches.

Knife switches, unless of the double-throw type, shall be so connected that the blades are dead when the switch is in the open position.

E-380.08. Accessibility and Grouping.

Switches and circuit-breakers, so far as practicable, shall be readily accessible and shall be grouped.

E-380.09. Covers of Flush Snap Switches.

Flush snap switches, that are mounted in ungrounded metal boxes and located within reach of conducting floors or other conducting surfaces, shall be provided with covers of non-conducting, noncombustible material. Face plates of non-ferrous metal shall be not less than 0.040 inch in thickness, of ferrous metal, not less than 0.030; and plates of non-conducting, noncombustible material shall be not less than 0.10 inch in thickness.

E-380.10. Mounting of Surface-Type Snap Switches.

Snap switches used with open wiring on insulators shall be mounted on sub-bases of insulating material which will separate the conductors at least  $\frac{1}{2}$  inch from the surface wired over.

E-380.11. Circuit-Breakers as Switches.

A circuit-breaker operable directly by applying the hand to a lever or handle may serve as a switch provided it has the number of poles required for such switch.

E-380.12. Grounding of Enclosures.

Enclosures for switches or circuit-breakers on circuits of over 150 volts to ground shall be grounded in the manner specified in Chapter E-250, except where

accessible to qualified operators only.

E-380.13. Knife Switches.

(1) Knife switches rated for more than 1200 amperes at 250 volts or less, and for more than 600 amperes at 251 to 600 volts, shall be used only as isolating switches and shall not be opened under load.

(2) To interrupt currents greater than 1200 amperes at 250 volts or less, or 600 amperes at 251 to 600 volts, a circuit-breaker or a switch of special design approved for such purpose shall be used.

(3) Knife switches of lower rating may be used as general-use switches and may be opened under load.

(4) Motor-circuit switches (see Definition) may be of the knife-switch type.

E-380.14. Rating of Snap Switches.

Snap switches installed for the following types of loads shall be rated as follows:

(1) Non-Inductive Loads. For non-inductive loads other than tungsten-filament lamps, switches shall have an ampere rating not less than the ampere rating of the load.

(2) Tungsten Filament Loads. For tungsten-filament lamp load and for combined tungsten-filament and non-inductive loads, switches shall be "T" rated or, where on alternating-current circuits, may be a general use alternating-current snap switch.

Exception. A switch that is not "T" rated may be installed to control such loads provided all three of the following qualifications are satisfied.

(1) Where switches are used in branch circuit wiring systems in private homes; in rooms in multiple-occupancy dwellings used only as living quarters by tenants; in private hospital or hotel rooms; or in similar locations but not in public rooms or places of assembly; and

(2) Only where such a switch controls permanently connected fixtures or

lighting outlets in one room only, or in one continuous hallway where the lighting fixtures may be located at different levels, or on porches or in attics or basements not used for assembly purposes; and

(3) The switch is rated at not less than 10A, 125V; 5A, 250V; or for the 4-way types, 5A, 125V; 2A, 250V.

(3) Inductive Loads. Switches controlling inductive loads shall have an ampere rating twice the ampere rating of the load unless they are of a type approved as part of an assembly or for the purpose employed. On alternating-current circuits, general use alternating-current snap switches may be used to control inductive loads other than motors not exceeding the ampere rating of the switch.

Note 1. For switches on signs and outline lighting, see E-600.02.

Note 2. For switches controlling motors, see E-430.083 and E-430.110.

#### B. Construction Specifications

##### E-380.15. Marking.

Switches shall be marked with the current and voltage and, if horsepower rated, the maximum rating for which they are designed.

##### E-380.16. 600-Volt Knife Switches.

Auxiliary contacts of a renewable or quick-break type or the equivalent, shall be provided on all 600-volt knife switches designed for use in breaking currents over 200 amperes.

Note: It is recommended that such auxiliary contacts be provided on all direct-current switches rated at over 250 volts.

##### E-380.17. Multiple Fuses.

Switches rated above 600 amperes may be arranged for fuses in multiple provided as few fuses as possible are used and the fuses are of the same type and rating and are so mounted as to eliminate a potential difference between the terminals of the fuses.

CHAPTER E-384

SWITCHBOARDS AND PANELBOARDS

E-384.01. Scope.

(1) The requirements of this Chapter shall apply to all switchboards, panelboards, and distribution boards installed for the control of light and power circuits.

Exception No. 1. Switchboards in utility company operated central stations or substations, which directly control energy derived from generators or transforming devices.

Exception No. 2. Switchboards or portions thereof used exclusively to control signal circuits operated by batteries.

(2) The requirements of this Chapter shall apply to battery-charging panels where current is taken from light or power circuits.

E-384.02. Application of Other Chapters.

Switches, circuit-breakers and overcurrent devices used on switchboards, panelboards and distribution boards, the boards and their enclosures, shall conform to the requirements of Chapters E-240, E-250, E-370, E-380 and other Chapters which apply. Switchboards and panelboards in hazardous locations shall conform to the requirements of Chapters E-500 to E-517 inclusive.

E-384.03. Support and Arrangement of Bus-bars and Conductors.

(1) Conductors and bus-bars on a switchboard, panelboard or control board shall be so located as to be free from physical damage and shall be held firmly in place.

(2) The arrangement of bus-bars and conductors shall be such as to avoid overheating due to inductive effects.

A. Switchboards

E-384.04. Location of Switchboards.

Switchboards which have any exposed live parts shall be located in permanently

dry locations and then only where under competent supervision and accessible only to qualified persons.

E-384.05. Wet Locations.

Where a switchboard is in a wet location or outside of a building, it shall be enclosed in a weather-proof enclosure or cabinet installed to conform to E-373.02.

E-384.06. Location Relative to Easily Ignitable Material.

Switchboards shall be so placed as to reduce to a minimum the probability of communicating fire to adjacent easily ignitable material.

E-384.07. Clearance from Ceiling.

Switchboards shall not be built up to a non-fireproof ceiling, a space of three feet being left between the ceiling and the board, unless an adequate fire-proof shield is provided between the board and the ceiling.

E-384.08. Clearance Back of Switchboard.

Where the equipment or wiring on the back of the switchboard is accessible only from the space behind the board, there shall be a clear space of at least 18 inches between such equipment or wiring and the wall for a single panel switchboard not exceeding 42 inches in width, and at least 24 inches when the board consists of a wider panel or more than one panel. Where the space behind the board is accessible only from one end, these spaces shall be increased by at least 6 inches. The space back of the board shall be kept clear of foreign material and shall not be used for storage purposes, nor as passageways.

Note 1. Reduction of clearances for short intervals by building columns behind the switchboard, or by equipment on a single panel in the switchboard, is permitted provided the clearances are not reduced below those required for a single panel board.

Note 2. Some of the above dimensions are exceptions to E-195.16.

E-384.09. Conductor Covering.

Insulated conductors where closely grouped, as on the rear of switchboards, shall each have a flame-retardant outer covering. The conductor covering shall be stripped back a sufficient distance from the terminals so as to not make contact with them. Insulated conductors used for instrument and control wiring on the back of switchboards shall be flame-retardant, either inherently or by means of an outer covering, such as one of the following types: R, RH, RW, RHH, RHW, V, AVA, AVB, T, TA, TBS, TW, THW, MI, or other types specifically approved for the purpose.

E-384.11. Grounding Switchboard Frames.

Switchboard frames and structures supporting switching equipment shall be grounded, except that frames of direct-current single-polarity switchboards need not be grounded if effectively insulated.

E-384.12. Grounding of Instruments, Relays, Meters and Instrument Transformers on Switchboards.

Instruments, relays, meters and instrument transformers located on switchboards shall be grounded as specified in E-250.121 to E-250.125.

B. Panelboards

E-384.13. General.

All panelboards shall have a rating not less than the minimum feeder capacity required for the load as computed from Chapter E-220.

E-384.14. Lighting and Appliance Branch Circuit Panelboard.

For the purposes of this rule, a lighting and appliance branch circuit panelboard is one having more than 10 per cent of its overcurrent devices rated 30 amperes or less, for which neutral connections are provided.

E-384.15. Number of Overcurrent Devices on One Panelboard.

Not more than 42 overcurrent devices of a lighting and appliance branch circuit panelboard shall be installed in any one cabinet or cutout box.

E-384.16. Overcurrent Protection.

(1) A lighting and appliance branch circuit panelboard supplied by conductors



having overcurrent protection greater than 200 amperes shall be protected on the supply side by overcurrent devices having a rating not greater than that of the panelboard.

Exception. Except as installed for service as in E-230.090(1).

(2) Panelboards equipped with snap switches rated at 30 amperes or less, shall have overcurrent protection not in excess of 200 amperes.

(3) The overcurrent protective devices of all panelboards installed in industrial or commercial buildings where loads continue for long periods of time, shall have a rating not less than 125 per cent of the circuit loading, as determined by Chapters E-210 and E-220.

E-384.17. Panelboards in Damp or Wet Locations.

Panelboards in damp or wet locations shall be installed in conformity to E-373.02.

E-384.18. Enclosure.

Panelboards shall be mounted in cabinets or cutout boxes.

E-384.19. Relative Arrangement of Switches and Fuses.

Panelboards having switches on the load side of any type of fuses shall not be installed except for use as service equipment as provided in E-230.094.

C. Construction Specifications

E-384.20. Panels.

The panels of switchboards shall be made of moisture-resistant, noncombustible material.

E-384.21. Bus-bars.

Bus-bars may be of bare metal provided they are rigidly mounted.

E-384.22. Protection of Instrument Circuits.

Instruments, pilot lights, potential transformers, and other switchboard devices with potential coils, except where the operation of the overcurrent device might introduce a hazard in the operation of devices, shall be supplied by a circuit that is protected by standard overcurrent devices of a rating not greater than

15 amperes, except that for ratings of 2 amperes or less special types of enclosed fuses may be used.

E-384.23. Component Parts.

Switches, fuses, and fuseholders used on panelboards shall conform to the requirements of Chapters E-240 and E-380 so far as they apply.

E-384.24. Knife Switches.

Knife switches shall be so arranged that the blades, when exposed during operation, will be dead when the switches are open.

E-384.25. Color-Coding.

On switchboards or panelboards that are provided with color markings to indicate the main bus-bars to which branch circuit bus-bars are connected, the colors shall conform to the color coding of E-210.05.

E-384.26. Spacings.

(1) Except at switches and circuit-breakers, the distance between bare metal parts, bus-bars, etc., shall be not less than specified in the following Table:

Table E-384.26 - Spacings Between Bare Metal Parts

	Opposite Polarity When Mounted on the Same Surface	Opposite Polarity When Held Free in Air	*Live Parts to Ground
Not over 125 volts . . . . .	3/4 inch	1/2 inch	1/2 inch
Not over 250 volts . . . . .	1-1/4 inch	3/4 inch	1/2 inch
Not over 600 volts . . . . .	2 inches	1 inch	1 inch

\*For spacing between live parts and doors of cabinets, see E-373.11(1).

Note: It should be noted that the above distances are the minimum allowable, and it is recommended that greater distances be provided wherever the conditions will permit.

(2) At switches, enclosed fuses, etc., parts of the same polarity may be

placed as close together as convenience in handling will allow, unless close proximity causes excessive heating.

## CHAPTER E-390

### PREFABRICATED BUILDINGS

#### E-390.01. Scope.

The intent and purpose of the following rules is to define approved methods for the wiring of prefabricated building sections, panels, or units designed for later erection or assembly as integral parts of buildings whether wired in the process of manufacture or at the site of erection or assembly.

#### E-390.02. Wiring Methods.

Only wiring methods recognized in this Code shall be used.

#### E-390.03. Code Provisions to Apply.

The provisions of this Code shall apply for the type of wiring method used and the type of construction employed.

CHAPTER E-391

TRAILERS

E-391.01. Wiring in Trailer.

The wiring in a trailer used as a permanent residence which is to be connected to a regular outside distribution system shall conform to the appropriate rules in this Code.

E-391.02. Connection of Trailer.

Whenever a trailer is parked and its wiring system connected to the regular distribution system, proper fusing and grounding shall be provided. The acceptable means of supplying this protection is as follows:

(1) For each trailer an outlet and conductors shall be provided for the connection of the trailer wiring system. The outlet and conductors on the regular distribution system shall consist of a fused switch, fused only on the ungrounded wire, approved receptacle, cable for supplying the energy, and a separate insulated conductor for grounding purposes. The cable and ground conductor shall be of approximately the same length. The ground conductor shall be attached to ground and to the neutral wire at the outlet and provided with a means of attaching to the trailer frame.

Note: Cable should be not over 20 feet in length and conductors should be at least No. 14 AWG.