EQUIPMENT FOR GENERAL USE

CHAPTER E-400

FLEXIBLE CORDS

A. General and Types

E-400.01. General.

Flexible cords shall be suitable for the conditions of use and location.

E-400.02. Types.

Cords of the several types shall conform to the descriptions of Table E-400.11. Types of flexible cords other than those listed in Table E-400.11 and other uses for types listed in the Table, shall be the subject of special investigations and shall not be used before being approved.

B. Use and Installation

E-400.03. Use.

Flexible cord may be used only for (1) pendants; (2) wiring of fixtures; (3) connection of portable lamps or appliances; (4) elevator cables; (5) wiring of cranes and hoists; (6) for the connection of stationary equipment to facilitate their interchange; or (7) to prevent the transmission of noise or vibration.

E-400.04. Prohibited Uses.

Flexible cord shall not be used (1) as a substitute for the fixed wiring of a structure; (2) where run through holes in walls, ceilings, or floors; (3) where run through doorways, windows, or similar openings; (4) where attached to building surfaces; or (5) where concealed behind building walls, ceilings, or floors.

E-400.05. Splices.

Flexible cord shall be used only in continuous lengths without splice or tap.

E-400.06. Cords in Show-Windows and Show-Cases.

Flexible cord used in show-windows and show-cases shall be of types S, SO, ST, SJO, ST, SJT, or AFS, except for the wiring of chain supported fixtures, and for

supplying current to portable lamps and other merchandise for exhibition purposes.

E-400.07. Minimum Size.

Flexible cord shall not be smaller than No. 18, except that tinsel cords, or cords having equivalent characteristics, of smaller size may be approved for use with specific appliances.

E-400.08. Insulation - Over 300 Volts.

Where the voltage between any two conductors exceeds 300, but does not exceed 600, flexible cord of No. 10 and smaller shall have rubber or thermoplastic insulation on the individual conductors at least 3/64 inch in thickness, unless type S, SO or ST cord is used.

E-400.09. Overcurrent Protection and Current-Carrying Capacities of Flexible Cords.

(1) Overcurrent Protection. Flexible cords not smaller than No. 18, and tinsel cords, or cords having equivalent characteristics, of smaller size approved for use with specific appliances, shall be considered as protected against overcurrent by the overcurrent devices described in E-240.05. Cords shall be not smaller than required in Table E-400.09(2) for the rated current of the appliance.

Table E-400.09(2). Current-Carrying Capacity of Flexible Cord in Amperes

Table E-400.09(2) gives the allowable current-carrying capacities for not more than three current-carrying conductors in a cord. If the number of current-carrying conductors in a cord is from four to six the allowable current-carrying capacity of each conductor shall be reduced to 80 per cent of the values in the Table. (Based on Room Temperature of 30°C (86°F.). See E-400.09 and Table E-400.11.)

Table E-400.09(2) Continued.

Size AWG	Rubber Types TP, TS		Rubber Types PO, C, PD, P, PW, K, E, EO		Rubber Types S, SO, SR, SJ, SJO, SV, SP		Types AFS, AFSJ, HC, HPD, HSJ, HS, HPN	Types AVPO, AVPD	Cotton Types CFC* CFPO* CFPD*	
	Thermo-plastic Types TPT, TSP		Thermo-plastic Type ET		Thermo-plastic Types ST, SRT, SJT, SVP, SPT				Asbestos Types AFC* AFPO* AFPD*	
27**	0.5		....		....		....	....	....	
18	...		5		7		10	17	6	
17	...		..		..		12	..	..	
16	...		7		10		15	22	8	
15	...		..		..		17	..	..	
14	...		15		15		20	28	17	
12	...		20		20		30	36	23	
10	...		25		25		35	47	28	
8	...		35		35		..	..	..	
6	...		45		45		..	..	..	
4	...		60		60		..	..	..	
2	...		80		..		..	..	..	

*These types are used almost exclusively in fixtures where they are exposed to high temperatures and ampere ratings are assigned accordingly.

**Tinsel Cord.

Note to Table E-400.09 (2)

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.

E-400.10. Pull at Joints and Terminals.

Flexible cords shall be so connected to devices and to fittings that tension will not be transmitted to joints or terminal screws. This shall be accomplished

by a knot in the cord, winding with tape, by a special fitting designed for that purpose, or by other approved means which will prevent a pull on the cord from being directly transmitted to joints or terminal screws.

Notes to Table E-400.11

1. Except for Types AFPO, CFPO, PO-1, PO-2, PO, SP-1, SP-2, SPT-1, SPT-2, TP, TPT, and AVPO, individual conductors are twisted together.

2. Type PO-1 is for use only with portable lamps, portable radio receiving appliances, portable clocks and similar appliances which are not liable to be moved frequently and where appearance is a consideration.

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

4. Type K is suitable for use on theatre stages.

5. Rubber-filled or varnished cambric tapes may be substituted for the inner braids.

6. Types S, SO, and ST are suitable for use on theatre stages, in garages and elsewhere, where flexible cords are permitted by this Code.

7. Traveling cables for operating, control and signal circuits may have one or more non-metallic fillers or may have a supporting filler of stranded steel wires having it's own protective braid or cover. Cables exceeding 100 feet in length shall have steel supporting fillers, except in locations subject to excessive moisture or corrosive vapors or gases. Where steel supporting fillers are used, they shall run straight through the center of the cable assembly and shall not be cabled with the copper strands of any conductor.

8. A third conductor in these cables is for grounding purposes only.

9. The individual conductors of all cords except those of heat-resistant cords (Types AFC. AFPO, AFPD, AFS, AFSJ, AVPO, AVPD, CFC, CFPO and CFPD) shall have a rubber or thermoplastic insulation, except that the grounding conductor where used, shall be in accordance with E-400.14(2). A rubber compound shall be vulcanized except for heater cords (Types HC, HPD and HSJ) and for belt fillers in Types P-1, P-2, PW-1, PW-2 and PW.

Table E-400.11 - Flexible Cord
(See E-400.02)

Trade Name	Type Letter	Size AWG	No. of Conductors	Insulation	Braid on Each Conductor	Outer Covering	Use		
Parallel Tinsel Cord	TP See Note 3	27	2	Rubber	None	Rubber	Attached to an Appliance	Damp Places	Not Hard Usage
	TPT See Note 3	27	2	Thermo-plastic	None	Thermo-plastic	Attached to an Appliance	Damp Places	Not Hard Usage
Jacketed Tinsel Cord	TS See Note 3	27	2 or 3	Rubber	None	Rubber	Attached to an Appliance	Damp Places	Not Hard Usage
	TST See Note 3	27	2 or 3	Thermo-plastic	None	Thermo-plastic	Attached to an Appliance	Damp Places	Not Hard Usage
Asbestos-Covered heat-Resistant Cord	AFC	18, 16 14	2 or 3	Impreg-nated Asbestos	Cotton or Rayon	None	Pendant	Dry Places	Not Hard Usage
	AFPO		2		None	Cotton, Rayon or Saturated Asbestos			
	AFPD		2 or 3						
Cotton-Covered Heat-Resistant Cord	CFC	18, 16 14	2 or 3	Impreg-nated Cotton	Cotton or Rayon	None	Pendant	Dry Places	Not Hard Usage
	CFPO		2		None	Cotton or Rayon			
	CFPD		2 or 3						

See Notes

Trade Name	Type Letter	Size AWG	No. of Conductors	Insulation	Braid on Each Conductor	Outer Covering	Use		
Parallel Cord	PO-1	18	2	Rubber	Cotton	Cotton or Rayon	See Note 2	Dry Places	Not Hard Usage
	PO-2	18, 16					Pendant or Port.		
	PO	18-10							
All Rubber Parallel Cord	SP-1	18	2	Rubber	None	Rubber	Pendant or Port.	Damp Places	Not Hard Usage
	SP-2	18, 16							
	SP-3 See Note 8	18-12		Rubber	None	Rubber	Refrigerators or Room Air Conditioners	Damp Places	Not Hard Usage
All Plastic Parallel Cord	SPT-1	18,16	2	Thermoplastic	None	Thermoplastic	Pendant or Portable	Damp Places	Not Hard Usage
	STP-2								
All Plastic Parallel Cord	SPT-3 See Note 8	18-12	2	Thermoplastic	None	Thermoplastic	Refrigerators or Room Air Conditioners	Damp Places	Not Hard Usage
Lamp Cord	C	18-10	2 or more	Rubber	Cotton	None	Pendant or Port.	Dry Places	Not Hard Useage
Twisted Portable Cord	PD	18-10	2 or more	Rubber	Cotton	Cotton or Rayon	Pendant or Port.	Dry Places	Not Hard Usage

See Notes

Table E-400.11 continued.

Reinforced Cord	P-1 P-2 P	18 18, 16 18-10	2 or more	Rubber	Cotton	Cotton over Rubber Filler	Pendant or Portable	Dry Places	Not Hard Usage Hard Usage
Moisture Proof Reinforced Cord	PW-1 PW-2 PW	18 18, 16 18-10	2 or more	Rubber	Cotton	Cotton, Moisture Resistant Finish over Rubber Filler	Pendant or Portable	Damp Places	Not Hard Usage Hard Usage
Braided Heavy Duty Cord	K See Note 4	18-10	2 or more	Rubber	Cotton	Two Cotton, Moisture-Resistant Finish See Note 5	Pendant or Portable	Damp Places	Hard Usage
Vacuum Cleaner Cord	SV SVT	18	2	Rubber Thermopl[1]	None	Rubber Thermoplastic	Pendant or Portable	Damp Places	Not Hard Usage
Junior Hard Service Cord	SJ SJO SJT	18, 16	2, 3 or 4	Rubber Thermpl[1] or Rubber	None	Rubber Oil Resist. Compound Thermoplastic	Pendant or Portable	Damp Places	Hard Usage
Hard Service Cord	S See Note 6 SO ST	18-10	2 or more	Rubber Thermopl[1] or Rubber	None	Rubber Oil Resist.Compound Thermoplastic	Pendant or Portable	Damp Places	Extra Hard Usage
Rubber-Jacketed Heat-Resistant Cord	AFSJ AFS	18, 16 18, 16, 14	2 or 3	Impregnated Asbestos	None	Rubber	Portable	Damp Places	Portable Heaters

Heater Cord	HC	18-12	2, 3, or 4	Rubber & Asbestos	Cotton	None	Portable	Dry Places	Portable Heaters
	HPD				None	Cotton or Rayon			
Rubber Jacketed Heater Cord	HSJ	18-16		Rubber & Asbestos	None	Cotton and Rubber	Portable	Damp Places	Portable Heaters
Jacketed Heater Cord	HS	14-12	2, 3, or 4	Rubber and Asbestos	None	Cotton and Rubber or Neoprene	Portable	Damp Places	Portable Heaters
All-Neoprene Heater Cord	HPN	18-16	2	Neoprene	None	Neoprene	Portable	Damp Places	Portable Heaters
Heat & Moisture Resistant Cord	AVPO	18-10	2	Asbestos & Var. Camb.	None	Asbestos, Flame-ret. Moisture Resist.	Pendant or Portable	Damp Places	Not Hard Usage
	AVPD		2 or 3						
Range Cable	SR	8-4	3 or 4	Rubber	None	Rubber or Neoprene	Portable	Damp Places	Ranges
	SRT	8-4	3 or 4	Thermoplastic	None	Thermoplastic	Portable	Damp Places	Ranges
Elevator Cable	E See Note 7	18-14	2 or more	Rubber	Cotton	Three Cotton, Outer one Flame-Retardant & Moisture Resist. See Note 5	Elevator Lighting and Control	Non-Hazardous Locations	
	EO See Note 7					One Cotton and a Neoprene Jacket See Note 5		Hazardous Locations	
	ET See Note 7	18-14		Thermoplastic	Rayon	Three Cotton, Outer one Flame-Retardant & Moisture Resistant. See Note 5		Non-Hazardous Locations	

See Notes

C. Construction Specifications

E-400.12. Labels.

Flexible cords shall be examined and tested at the factory and shall be labeled before shipment.

E-400.13. Grounded Conductor Identification.

One conductor of flexible cords shall have a continuous marker readily distinguishing it from the other conductor or conductors. The identification shall consist of one of the following:

(1) Colored Braid. A braid finished to show a white or natural gray color and the braid on the other conductor or conductors finished to show a readily distinguishable solid color or colors.

(2) Tracer in Braid. A tracer in a braid of any color contrasting with that of the braid and no tracer in the braid of the other conductor or conductors. No tracer shall be used in the braid of any conductor of a flexible cord which contains a conductor having a braid finished to show white or natural gray, except, in the case of Types C, PD and PO cords having the braids on the individual conductors finished to show white or natural gray. In such C, PD and PO cords the identifying marker may consist of the solid white or natural gray finish on one conductor provided there is a colored tracer in the braid of each other conductor.

(3) Colored Insulation. A white or natural gray insulation on one conductor and insulation of a readily distinguishable color or colors on the other conductor or conductors for cords having no braids on the individual conductors (except cords which have insulation on the individual conductors integral with the jacket).

(4) Colored Separator. A white or natural gray separator on one conductor and a separator of a readily distinguishable solid color on the other conductor or conductors of cords having insulation on the individual conductors integral with the jacket.

(5) Tinned Conductors. One conductor having the individual strands tinned

and the other conductor or conductors having the individual strands untinned for cords having insulation on the individual conductors integral with the jacket.

(6) Surface Marking. A stripe, ridge or groove so located on the exterior of the cord as to identify one conductor for cords having insulation on the individual conductors integral with the jacket.

E-400.14. Grounding Conductor Identification.

A conductor intended to be used as a grounding conductor shall have a continuous identifying marker readily distinguishing it from the other conductor or conductors. The identifying marker shall consist of one of the following:

(1) Colored Braid. A braid finished to show a green color.

(2) Colored Insulation or Covering. For cords having no braids on the individual conductors a green insulation or green covering on one conductor.

E-400.15. Insulation Thickness.

The nominal thickness of rubber or thermoplastic conductor insulation in Types TS, TST, PO-1, P-1, PW-1, SV, and SVT shall be not less than 1/64 inch. The nominal thickness of rubber insulation in Types HC, HPD, HSJ, and HS shall be not less than 1/64 inch for the Nos. 18-16 AWG sizes, and not less than 2/64 inch for the Nos. 14-12 AWG sizes. The nominal thickness of the thermoplastic insulation in Type ET elevator cable shall be not less than 20 mils for the No. 16 AWG size and not less than 1/32 inch for the No. 14 AWG size. The nominal thickness of the rubber insulation in Types E and EO elevator cables shall be not less than 20 mils for the No. 18 and 16 AWG sizes. The nominal thickness of latex-rubber insulation, when employed, in Types SJ, SJO, S and SO shall be not less than 15 mils for the Nos. 18-16 AWG sizes and not less than 18 mils for the No. 14 AWG and larger sizes. The nominal thickness of conductor insulation in Types PO, P, PW, SP-2, SPT-2, HPN, SR, and SRT shall be not less than 3/64 inch. The nominal thickness of thermoplastic insulation in Type SPT-3 shall be not less than 4/64 inch for sizes 18-16 and 5/64 inch for No. 14 AWG and 6/64 inch for No. 12 AWG. For other

types, the minimum nonimal thickness of rubber or thermoplastic conductor insulation shall be as follows: size AWG 27, and 18 to 16 - 2/64 inch; 14 to 10 - 3/64 inch; 8 - 4/64 inch.

E-400.16. Attached to Receptacle Plugs.

Where a flexible cord is provided with a grounding conductor and equipped with an attachment plug, the plug shall comply with E-250.059(1) and (2).

CHAPTER E-402

FIXTURE WIRES

E-402.01. Use.

Fixture wires are designed for installation in lighting fixtures and in similar equipment where enclosed or protected and not subject to bending or twisting in use. Also, they are used for connecting lighting fixtures to the conductors of the circuit that supplies the fixtures.

Note 1. For application in lighting fixtures, See Chapter E-410.

Note 2. Fixture wires are not intended for installation as branch circuit conductors or for the connection of portable or stationary appliances.

E-402.02. Minimum Size.

Fixture wires shall not be smaller than No. 18.

E-402.03. Insulation.

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

Note: 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).

(2) 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.

Table E-402.04

ALLOWABLE CURRENT-CARRYING CAPACITY OF FIXTURE WIRE

(Based on Room Temperature of 30°C., 86°F.)

Size AWG	Fixture Wire		
	Rubber Types RF-1, RF-2, FF-1, FF-2, RFH-1, RFH-2, FFH-1, FFH-2	Thermoplastic Types TF, TFF Cotton Type CF* Asbestos Type AF* Silicone Rubber Types SF-1*, SF-2*, SFF-1*, SFF-2*	
18	5	6	
16	7	8	
14	..	17	

*These types are used almost exclusively in fixtures where they are exposed to high temperatures and ampere ratings are assigned accordingly.

Note: 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.

E-402.05. Overcurrent Protection. See E-240.05.

Table E-402.06 - FIXTURE WIRE

Trade Name	Type Letter	Insulation	Thickness of Insulation	Outer Covering
Rubber-Covered Fixture Wire Solid or 7-Strand	RF-1	Code Rubber	18 . . . . . 1/64 Inch	Non-metallic covering
	RF-2	Code Rubber	18-16 . . . . . 2/64 Inch	Non-metallic covering
		Latex Rubber	18-16 . . . . . 18 Mils	
Rubber-Covered Fixture Wire Flexible Stranding	FF-1	Code Rubber	18 . . . . . 1/64 Inch	Non-metallic covering
	FF-2	Code Rubber	18-16 . . . . . 2/64 Inch	Non-metallic covering
		Latex Rubber	18-16 . . . . . 18 Mils	
Heat Resistant Rubber-Covered Fixture Wire Solid or 7-Strand	RFH-1	Heat-Resistant Rubber	18 . . . . . 1/64 Inch	Non-metallic covering
	RFH-2	Heat-Resistant Rubber	18-16 . . . . . 2/64 Inch	Non-metallic covering
		Heat-Resistant Latex Rubber	18-16 . . . . . 18 Mils	
Heat Resistant Rubber-Covered Fixture Wire Flexible Stranding	FFH-1	Heat-Resistant Rubber	18 . . . . . 1/64 Inch	Non-metallic covering
	FFH-2	Heat-Resistant Rubber	18-16 . . . . . 2/64 Inch	Non-metallic covering
		Heat-Resistant Latex Rubber	18-16 . . . . . 18 Mils	
Thermoplastic-Covered Fixture Wire - Solid or Stranded	TF	Thermoplastic	18-16 . . . . . 2/64 Inch	None

Trade Name	Type Letter	Insulation	Thickness of Insulation	Outer Covering
Thermoplastic-Covered Fixture Wire - Flexible Stranding	TFF	Thermoplastic	18-16 . . . . . 2/64 Inch	None
Cotton-Covered, Heat-Resistant, Fixture Wire	CF	Impregnated Cotton	18-14 . . . . . 2/64 Inch	None
Asbestos-Covered, Heat-Resistant, Fixture Wire	AF	Impregnated Asbestos	18-14 . . . . . 2/64 Inch	None
Silicone Insulated Fixture Wire Solid or 7-Strand	SF-1	Silicone Rubber	18 . . . . . 1/64 Inch	Non-Metallic Covering
	SF-2	Silicone Rubber	18-14 . . . . . 1/32 Inch	Non-Metallic Covering
Silicone Insulated Fixture Wire Flexible Stranding	SFF-1	Silicone Rubber	18 . . . . . 1/64 Inch	Non-Metallic Covering
	SFF-2	Silicone Rubber	18-14 . . . . . 1/32 Inch	Non-Metallic Covering

CHAPTER E-410

LIGHTING FIXTURES, LAMPHOLDERS, LAMPS RECEPTACLES AND ROSETTES

A. General

E-410.01. Scope.

Lighting fixtures, lampholders, pendants, receptacles, and rosettes, incandescent filament lamps, arc lamps, electric discharge lamps, the wiring and equipment forming part of such lamps, fixtures and lighting installations shall conform to the provisions of this Chapter, except as otherwise provided in this code.

E-410.02. Application to Other Chapters.

Equipment for use in hazardous locations shall conform to Chapters E-500 to E-517.

E-410.03. Live Parts.

Fixtures, lampholders, lamps, rosettes and receptacles shall have no live parts normally exposed to contact, except in the case of cleat-type lampholders, receptacles and rosettes which are located at least 8 feet above the floor. Lampholders, receptacles and switches which have exposed accessible terminals shall not be installed in metal fixture canopies or in open bases of portable table or floor lamps.

B. Provisions For Fixture Locations

E-410.04. Fixtures in Damp, Wet or Corrosive Locations.

(1) Fixtures installed in damp or wet locations shall be approved for such locations and shall be so constructed or installed that water cannot enter or accumulate in wireways, lampholders or other electrical parts.

(2) Fixtures installed in corrosive locations shall be of a type approved for such locations.

E-410.05. Fixtures near Combustible Material.

Fixtures shall be so constructed, or installed, or equipped with shades or

guards that combustible material will not be subjected to temperatures in excess of 90°C (194°F).

E-410.06. Fixtures over Combustible Material.

Lampholders installed over highly combustible material shall be of the unswitched type and unless an individual switch is provided for each fixture, shall be located at least 8 feet above the floor, or shall be otherwise so located or guarded that the lamps cannot be readily removed or damaged.

E-410.07. Fixtures in Show-Windows.

Externally wired fixtures shall not be used in a show-window.

Exception: Fixtures of the chain-supported type may be externally wired.

E-410.08. Fixtures in Clothes Closets.

(1) Fixtures in clothes closets shall be installed on the ceiling or on the wall above the door.

(2) Pendants shall not be installed in clothes closets.

E-410.09. Space for Cove Lighting.

Coves shall have adequate space and shall be so located that lamps and equipment can be properly installed and maintained.

C. Provisions at Fixture Outlet Boxes, Canopies and Pans

E-410.10. Space for Conductors.

Canopies and outlet boxes taken together shall provide adequate space so that fixture conductors and their connecting devices may be properly installed.

E-410.11. Temperature Limit of Conductors in Outlet Boxes.

Fixtures shall be of such construction or so installed that the conductors in outlet boxes shall not be subjected to temperatures greater than that for which the conductors are approved.

E-410.12. Outlet Boxes to be Covered.

In a completed installation, each outlet box shall be provided with a cover unless covered by means of a fixture canopy, lampholder, receptacle, rosette, or

similar device.

E-410.13. Covering of Combustible Material at Outlet Boxes.

Any combustible wall or ceiling finish exposed between the edge of a fixture canopy or pan and an outlet box shall be covered with non-combustible material.

E-410.14. Connection of Fixtures.

In general, fluorescent fixtures when supported independently of the outlet box shall be connected through metal raceways or armored conductors. This requirement may be waived when cord-equipped fixtures are suspended directly below the outlet box and the exposed cord is not subject to strain or physical damage.

D. Fixture Supports

E-410.15. Supports - General.

Fixtures, lampholders, rosettes and receptacles shall be securely supported. A fixture which weighs more than 6 lbs. or exceeds 16 inches in any dimension shall not be supported by the screw shell of a lampholder.

E-410.16. Means of Support.

Where the outlet box or fitting will provide adequate support, a fixture shall be attached thereto; otherwise a fixture shall be supported as required by E-370.13. A fixture which weighs more than 50 lbs. shall be supported independently of the outlet box.

E. Wiring of Fixtures

E-410.17. Fixture Wiring - General.

Wiring on or within fixtures shall be neatly arranged and shall not be exposed to physical damage. Excess wiring shall be avoided. Conductors shall be so arranged that they shall not be subjected to temperatures above those for which they are approved.

E-410.18. Conductor Size.

Fixture conductors shall not be smaller than No. 18.

E-410.19. Conductor Insulation.

(1) Fixtures shall be wired with conductors having insulation suitable for

the current, voltage, and temperature to which the conductors will be subjected.

(2) Where fixtures are installed in damp, wet, or corrosive locations, conductors shall be of a type approved for such locations.

(3) For current-carrying capacity of fixture wire, see Table E-402.04.

(4) For maximum operating temperature and voltage limitation of fixture wires, see E-310.02.

E-410.20. Conductors for Certain Conditions.

(1) Fixtures provided with Mogul base screw-shell lampholders and operating at not more than 300 volts between conductors shall be wired with Type AF, SF-1, SF-2, SFF-1 or SFF-2 fixture wire.

(2) Fixtures provided with other than Mogul base screw-shell lampholders and operating at not more than 300 volts between conductors shall be wired with Type AF, SF-1, SF-2, SFF-1, SFF-2 fixture wire or Type AFC, AFPO, or AFPD flexible cord.

Exception No. 1. Where temperatures do not exceed 90°C (194°F), Type CF fixture wire or Type CFC, CFPD, or CFPO flexible cord may be used.

Exception No. 2. Where temperatures exceed 60°C but are not higher than 75°C, Type RH rubber-covered wire, Type RFH-1, RFH-2, FFH-1, and FFH-2 fixture wires may be used.

Exception No. 3. Where temperatures do not exceed 60°C (140°F), Type T thermoplastic wire, Types TF and TFF fixture wire, Type R rubber-covered wire, and Types RF-1, RF-2, FF-1, FF-2 fixture wire may be used, including use in fixtures of decorative type on which lamps of not over 60-watt rating are used in connection with imitation candles.

Note: See E-402.06 and E-310.02 for fixture wires and conductors; also, Table E-400.09 (2) for flexible cords.

E-410.21. Conductors for Movable Parts.

(1) Stranded conductors shall be used on chain fixtures and other movable parts.

(2) Conductors shall be so arranged that the weight of the fixture or movable parts will not put a tension on the conductors.

E-410.22. Pendent Conductors for Incandescent Filament Lamps.

(1) Pendent lampholders with permanently attached leads, where used in other than festoon wiring, shall be hung from separate stranded rubber-covered conductors which are soldered directly to the circuit conductors but supported independently thereof.

(2) Such pendent conductors shall be not smaller than No. 14 for heavy-duty or medium-base screw-shell lampholders, nor, except for approved Christmas tree and decorative lighting outfits, smaller than No. 18 for intermediate or candelabra-base lampholders.

(3) Pendent conductors longer than 3 feet shall be twisted together where not cabled in an approved assembly.

E-410.23. Protection of Conductors.

(1) Conductors shall be secured in a manner that will not tend to cut or abrade the insulation.

(2) Conductors shall be protected from abrasion where they pass through metal.

(3) Exposed flexible cord or fixture wire shall not be used to supply permanently installed fixtures in show cases or wall cases.

E-410.24. Conductor Protection at Lampholders.

Where a metal lampholder is attached to a flexible cord, the inlet shall be equipped with an insulating bushing which, if threaded, shall not be smaller than nominal 3/8 inch pipe size. The edges of the bushing shall be rounded and all inside fins removed in order to provide a smooth bearing surface for the conductors.

Note: Bushings having holes 9/32 inch in diameter are suitable for use with plain pendent cord and holes 13/32 inch in diameter with reinforced cord.

E-410.25. Connections, Splices and Taps.

(1) Fixtures shall be so installed that the connections between the fixture conductors and the circuit conductors may be inspected without requiring the disconnection of any part of the wiring, unless the fixture is connected by means of a plug and receptacle.

(2) Splices and taps shall not be located within fixture arms or stems.

(3) No unnecessary splices or taps shall be made within or on a fixture.

(4) For approved means of making connections, see E-195.13 and E-195.14.

E-410.26. Fixture Raceways.

(1) Fixtures shall not be used as a raceway for circuit conductors unless the fixtures meet the requirements of approved raceways, except that the conductors of a single branch circuit may be carried through an installation of fixtures approved for end to end assembly to form a continuous raceway.

(2) Individual fixtures of all types which are coupled, butted, telescoped, or connected together with metal raceways not over eighteen (18) inches in length, shall be considered as a single fixture.

E-410.27. Polarization of Fixtures.

Fixtures shall be so wired that the screw-shells of lampholders will be connected to the same fixture or circuit conductor or terminal. For polarity identification of conductors to screw-shells of lampholders, see E-200.08.

F. Construction of Fixtures.

E-410.28. Combustible Shades and Enclosures.

Adequate air space shall be provided between lamps and shades or other enclosures of combustible material.

E-410.29. Fixture Rating.

(1) All fixtures requiring ballasts or transformers shall be plainly marked with their electrical rating and the manufacturer's name, trade-mark or other suitable means of identification.

(2) The electrical rating shall include the voltage and frequency, and shall indicate the current rating of the unit including the ballast, transformer or auto-transformer.

E-410.30. Design and Material.

Fixtures shall be constructed of metal, wood, or other approved material and shall be so designed and assembled as to secure requisite mechanical strength and rigidity. Wireways, including the entrances thereto, shall be such that conductors may be drawn in and withdrawn without injury.

E-410.31. Non-Metallic Fixtures.

In all fixtures not made entirely of metal, wireways shall be lined with metal unless approved armored or lead-covered conductors with suitable fittings are used.

E-410.32. Mechanical Strength.

(1) Tubing used for arms and stems where provided with cut threads shall be not less than 0.040 inch in thickness and when provided with rolled (pressed) threads shall be not less than 0.025 inch in thickness. Arms and other parts shall be fastened to prevent turning.

(2) Metal canopies supporting lampholders, shades, etc., exceeding 8 lbs., or incorporating attachment plug receptacles, shall be not less than 0.020 inch in thickness. Other canopies shall be not less than 0.016 inch when made of steel and not less than 0.020 inch when of other metals.

(3) Pull type canopy switches shall not be inserted in the rims of metal canopies which are less than 0.025 inch in thickness unless the rims are reinforced by the turning of a bead or the equivalent. Pull type canopy switches, whether mounted in the rims or elsewhere in sheet metal canopies, shall be located not more than $3\frac{1}{2}$ inches from the center of the canopy. Double set screws, double canopy rings, a screw ring, or equal method shall be used where the canopy supports a pull type switch or pendent receptacle.

Note: The above thickness requirements apply to measurements made on finished (formed) canopies.

E-410.33. Wiring Space.

Bodies of fixtures, including portable lamps, shall provide ample space for splices and taps and for the installation of devices, if any. Splice compartments shall be of non-absorptive, non-combustible material.

E-410.34. Fixture Studs.

Fixture studs which are not parts of outlet boxes, hickeys, tripods, and crow-feet shall be made of steel, malleable iron, or other approved material.

E-410.35. Insulating Joints.

Insulating joints shall be composed of materials especially approved for the purpose. Those which are not designed to be mounted with screws or bolts shall have a substantial exterior metal casing, insulated from both screw connections.

E-410.36. Portable Lamps.

Portable table and floor lamps and fan motors on ceiling fixtures may be wired with approved rubber-covered conductors, provided the wiring is not located so as to be subject to undue heating from lamps.

E-410.37. Portable Handlamps.

Handlamps of the portable type supplied through flexible cords shall be of the molded composition or other type approved for the purpose. Metal-shell paper-lined lampholders shall not be used. Handlamps shall be equipped with a handle. Where subject to physical damage or where lamps may come in contact with combustible material, handlamps shall be equipped with a substantial guard attached to the lampholder or the handle.

Note: For garages, see E-511.06.

E-410.38. Cord Bushings.

Bushing or the equivalent shall be provided where flexible cord enters the base or stem of a portable lamp. The bushing shall be of insulating material unless a jacketed type of cord is used.

E-410.39. Tests.

All wiring shall be free from short-circuits and grounds, and shall be tested for these defects prior to being connected to the circuit.

E-410.40. Live Parts.

Exposed live parts within porcelain fixtures shall be suitably recessed and so located as to make it improbable that wires will come in contact with them. There shall be a spacing of at least ½ inch between live parts and the mounting plane of the fixture.

G. Installation of Lampholders

E-410.41. Screw-Shell Type.

Lampholders of the screw-shell type shall be installed for use as lampholders only.

E-410.42. Double-Pole Switched Lampholders.

Where used on unidentified 2-wire circuits tapped from the ungrounded conductors of multi-wire circuits, the switching device of lampholders of the switched type shall simultaneously disconnect both conductors of the circuit. See E-200.05.

E-410.43. Lampholders in Damp or Wet Locations.

Lampholders installed in damp or wet locations shall be of the weatherproof type.

H. Construction of Lampholders

E-410.44. Insulation.

The outer metal shell and the cap shall be lined with insulating material which shall prevent the shell and cap from becoming a part of the circuit. The lining shall not extend beyond the metal shell more than 1/8 inch, but shall prevent any current-carrying part of the lamp base from being exposed when a lamp is in the lampholding device.

E-410.45. Lead Wires.

Lead wires, furnished as a part of weatherproof lampholders and intended to

be exposed after installation, shall be of approved, stranded, rubber-covered conductors, not less than No. 14 gauge (No. 18 gauge for candelabra sockets), and shall be sealed in place or otherwise made raintight.

E-410.46. Switched Lampholders.

Switched lampholders shall be of such construction that the switching mechanism interrupts the electrical connection to the center contact. The switching mechanism may also interrupt the electrical connection to the screw shell when connection to the center contact is simultaneously interrupted.

J. Lamps

E-410.49. Bases, Incandescent Lamps.

An incandescent lamp for general use on lighting branch circuits shall not be equipped with a Medium base when rated over 300 watts, nor with a Mogul base when rated over 1,500 watts. Above 1,500 watts, special approved bases or other devices shall be used.

E-410.50. Enclosures, Mercury-Vapor Lamp Auxiliary Equipment.

Resistors or regulators for mercury-vapor lamps shall be enclosed in noncombustible cases and treated as sources of heat.

E-410.51. Arc Lamps.

Arc lamps used in theatres shall conform to E-520.61, and arc lamps used in projection machines shall conform to E-540.20. Arc lamps used on constant-current systems shall conform to the general requirements of Chapter E-710.

K. Receptacles

E-410.52. Rating and Type.

(1) Receptacles installed for the attachment of portable cords shall be rated at not less than 15 amperes, 125 volts, or 10 amperes, 250 volts, and shall be of a type not suitable for use as lampholders.

(2) Faceplates of non-ferrous metal shall be not less than 0.040 inch in thickness, and of ferrous metal, not less than 0.030, and plates of non-conducting, non-combustible material shall be not less than 0.10 inch in thickness.

E-410.53. Receptacles in Floors.

Receptacles located in floors shall be enclosed in floor boxes especially approved for the purpose.

Exception: Where such receptacles are located in elevated floors of show-windows or other locations and when the administrative authority judges them to be free from physical damage, moisture and dirt, the standard approved type of flush receptacle box may be used.

E-410.54. Receptacles in Damp or Wet Locations.

Receptacles installed in damp or wet locations shall be of the weatherproof type.

E-410.55. Receptacles - Grounding Type.

Receptacles (1) installed for the attachment of flexible cords that have a grounding conductor, (2) having a maximum rating of 15 amperes at a potential between 151 and 300 volts; or having a maximum rating of either 15 or 20 amperes at a maximum potential of 150 volts, (3) having two current-carrying contacts and one fixed grounding member, and (4) having a terminal for the connection of a grounding conductor, shall have this grounding terminal of a distinctly different appearance from the other two terminals.

E-410.56. Attachment Plugs.

Attachment plugs for use with grounding type receptacles, E-410.55, and having two current-carrying contacts and one fixed grounding member shall have this grounding member so designed as to prevent it making contact with either of the current-carrying contacts of the receptacle. Any terminal for the connection of a grounding conductor shall be of distinctly different appearance from the other two terminals.

L. Rosettes

E-410.57. Approved Types.

(1) Fusible rosettes shall not be installed.

(2) Separable rosettes which make possible a change in polarity shall not be used.

E-410.58. Rosettes in Damp and Wet Locations.

Rosettes installed in damp or wet locations shall be of the weatherproof type.

E-410.59. Rating.

Rosettes shall be rated at 660 watts, 250 volts, with a maximum current rating of 6 amperes.

E-410.60. Rosettes for Exposed Wiring.

When designed for use with exposed wiring, rosettes shall be provided with bases which shall have at least two holes for supporting screws, shall be high enough to keep the wires and terminals at least ½ inch from the surface wired over, and shall have a porcelain lug under each terminal to prevent the rosette being placed over projections which would reduce the separation to less than ½ inch.

E-410.61. Rosettes for Use With Boxes or Raceways.

When designed for use with conduit boxes or wire raceways, rosette bases shall be high enough to keep wires and terminals at least 3/8 inch from the surface wired over.

M. Special Provisions for Flush and Recessed Fixtures

E-410.62. Approved Type.

Fixtures which are installed in recessed cavities in walls or ceilings shall be of an approved type and shall conform to E-410.63 to E-410.70 inclusive.

E-410.63. Temperature.

(1) Fixtures shall be so constructed or installed that adjacent combustible material will not be subjected to temperatures in excess of 90°C (194°F).

(2) Where a fixture is recessed in fire-resistant material in a building of fire-resistant construction, a temperature higher than 90°C (194°F), but not higher than 150°C (320°F) is acceptable if the fixture is plainly marked that it is approved for that service.

E-410.64. Clearance.

Recessed portions of enclosures, other than at points of support, shall be spaced at least $\frac{1}{2}$ inch from combustible material.

E-410.65. Wiring.

(1) Conductors having insulation suitable for the temperature encountered shall be used.

(2) Fixtures having branch circuit terminal connections which operate at temperatures higher than 60°C (140°F) shall have circuit conductors as described in E-410.65 (2)(a) and (2)(b):

(a) Branch circuit conductors having an insulation suitable for the temperature encountered may be run directly to the fixture.

(b) Tap connection conductors having an insulation suitable for the temperature encountered shall be run from the fixture terminal connection to an outlet box placed at least one foot from the fixture. Such a tap shall extend for at least four feet but not more than six feet and shall be in a suitable metal raceway.

N. Construction; Flush and Recessed Fixtures

E-410.66. Temperature.

Fixtures shall be so constructed that adjacent combustible material will not be subject to temperatures in excess of 90°C (194°F).

E-410.67. Enclosure.

Sheet metal enclosures shall be protected against corrosion by galvanizing, plating, or other equivalent heat-resisting coating, and shall not be less than No. 22 MS (USS revised) gauge in thickness.

E-410.68. Lamp Wattage Marking.

Incandescent lamp fixtures shall be marked to indicate the maximum allowable wattage of lamps. The markings shall be permanently installed, in letters at least $\frac{1}{4}$ inch high, and located where visible during relamping.

E-410.69. Solder Prohibited.

No solder shall be used in the construction of the fixture box.

E-410.70. Lampholders.

Lampholders of the screw-shell type shall be of porcelain unless specially approved for the purpose. Cements, where used, shall be of the high-heat type.

P. Special Provisions for Electric Discharge Lighting Systems of 1,000 Volts or Less

E-410.71. General.

(1) Equipment for use with electric discharge lighting systems and designed for an open-circuit voltage of 1,000 volts or less shall be of a type approved for such service.

(2) The terminals of an electric discharge lamp shall be considered as alive where any lamp terminal is connected to a potential of more than 300 volts.

(3) Transformers of the oil-filled type shall not be used.

(4) In addition to complying with the general requirements for lighting fixtures, such equipment shall conform to Part P of this Chapter.

E-410.72. Direct-Current Equipment.

Fixtures installed on direct current circuits shall be equipped with auxiliary equipment and resistors especially designed and approved for direct current operation and the fixtures shall be so marked.

E-410.73. Voltages - Dwelling Occupancies.

(1) Equipment having an open-circuit voltage of more than 1,000 volts shall not be installed in dwelling occupancies.

(2) Equipment having an open-circuit voltage of more than 300 volts shall not be installed in dwelling occupancies unless such equipment is so designed that there shall be no exposed live parts when lamps are being inserted, are in place, or are being removed.

E-410.74. Fixture Mounting.

(1) Exposed Ballasts. Fixtures having exposed ballasts or transformers shall be so installed that such ballasts or transformers shall not be in contact with combustible material.

(2) Combustible Low-Density Cellulose Fiberboard. Where a fixture containing a ballast is to be installed on combustible low-density cellulose fiberboard it shall, where surface mounted:

(a) Be approved for this condition, or

(b) Be spaced not less than 1½ inches from the surface of the fiberboard.

(c) Where such fixtures are partially or wholly recessed, the provisions of E-410.62 to E-410.70 shall apply.

Note: Combustible low-density cellulose fiberboard is considered to include sheets, panels and tiles which have a density of 20 pounds per cubic foot or less, and which are formed of bonded plant fiber material; but does not include solid or laminated wood, nor fiberboard which has a density in excess of 20 pounds per cubic foot.

E-410.75. Auxiliary Equipment Not Integral with Fixture.

(1) Auxiliary equipment, including reactors, capacitors, resistors, and similar equipment, where not installed as part of a lighting fixture assembly shall be enclosed in accessible, permanently-installed metal cabinets.

(2) Such separate equipment should be installed close to the lamps to keep the conductors between lamps and auxiliaries as short as possible. Where display cases are not permanently installed, no portion of a secondary circuit may be included in more than a single case.

(3) Ballasts approved for separate mounting and for direct connection to an approved wiring system need not be separately enclosed.

E-410.76. Auto-Transformers.

An auto-transformer which is used as part of a ballast for supplying lighting units and which raises the voltage to more than 300 volts shall be supplied only by a grounded system.

E-410.77. Switches.

Snap switches shall conform to E-380.14.

Q. Special Provisions for Electric Discharge Lighting Systems of More Than 1,000 Volts

E-410.78. General.

(1) Equipment for use with electric discharge lighting systems and designed for an open-circuit voltage of more than 1,000 volts shall be of a type approved for such service.

(2) The terminal of an electric discharge lamp shall be considered as alive when any lamp terminal is connected to a potential of more than 300 volts.

(3) In addition to complying with the general requirements for lighting fixtures, such equipment shall conform to E-410.78 to E-410.90 inclusive.

Note: For signs and outline lighting, see Chapter E-600.

E-410.79. Control.

(1) Fixtures or lamp installations shall be controlled either singly or in groups by an externally-operable switch or circuit-breaker which shall open all ungrounded primary conductors.

(2) The switch or circuit-breaker shall be located within sight of the fixtures or lamps, or it may be located elsewhere if it is provided with means for locking in the open position.

E-410.80. Lamp Terminals and Lampholders.

Parts which must be removed for lamp replacement shall be hinged or fastened by an approved means. Lamps or lampholders or both shall be so designed that there shall be no exposed live parts when lamps are being inserted or are being removed.

E-410.81. Transformer Ratings.

Transformers and ballasts shall have a secondary open-circuit voltage of not more than 15,000 volts with an allowance on test of 1,000 volts additional. The secondary current rating shall be not more than 120 milli-amperes when the open circuit voltage is more than 7500 volts, and not more than 240 milli-amperes when the open circuit voltage is 7500 volts or less.

E-410.82. Transformer Type.

Transformers shall be of an approved enclosed type. Transformers of other than the askarel insulated or dry type shall not be used.

E-410.83. Transformer Secondary Connections.

(1) The high-voltage windings of transformers shall not be connected in series or in parallel, except that for two transformers, each having one end of its high-voltage winding grounded and connected to the enclosure, the high-voltage windings may be connected in series to form the equivalent of a mid-point grounded transformer.

(2) The grounded ends shall be connected by an insulated conductor not smaller than No. 14 AWG.

E-410.84. Transformer Locations.

(1) Transformers shall be accessible after installation.

(2) The transformers should be installed as near to the lamps as practicable to keep the secondary conductors as short as possible.

(3) Transformers shall be so located that adjacent combustible materials will not be subjected to temperatures in excess of 90°C (194°F).

E-410.85. Transformer Loading.

The lamps connected to any transformer shall be of such length and characteristics as not to cause a condition of continuous over-voltage on the transformer.

E-410.86. Wiring Method. Secondary Conductors.

Approved gas-tube sign cable suitable for the voltage of the circuit shall be used. For installation of conductors, see E-600.31.

E-410.87. Lamp Supports.

Lamps shall be adequately supported as required in E-600.33.

E-410.88. Exposure to Damage.

Lamps shall not be located where normally exposed to physical damage.

E-410.89. Marking.

Each fixture or each secondary circuit of tubing having an open-circuit voltage of more than 1,000 volts shall have a clearly legible marking in letters not less than $\frac{1}{4}$ inch high reading "Caution . . . . . .volts". The voltage indicated shall be the rated open-circuit voltage.

E-410.90. Switches.

Snap switches shall conform to E-380.14.

R. Grounding

E-410.91. General.

Fixtures and lighting equipment shall be grounded as provided in E-410.92 to E-410.96 inclusive.

E-410.92. Metallic Wiring Systems.

Metal fixtures installed on outlets wired with grounded metal raceway or grounded armored cable shall be grounded.

E-410.93. Non-Metallic Wiring Systems.

Metal fixtures installed on outlets wired with knob-and-tube work, or non-metallic sheathed cable, on circuits operating at 150 volts or less to ground, shall be grounded.

Exception No. 1. Fixtures mounted on metal or metal lath ceilings or walls may be insulated from their supports and from the metal lath by the use of insulating joints or fixture supports and canopy insulatiors. See E-410.95.

Exception No. 2. Fixtures not mounted on metal or metal-lath ceilings or walls need not be insulated or grounded. See E-410.95.

Note: Fixtures made of insulating materials, and lampholders with shells of insulating material, are recommended for use with wiring systems that do not afford a ready means for grounding the exposed non-current-carrying parts of fixtures and lampholders.

E-410.94. Equipment of More Than 150 Volts to Ground.

(1) Metal fixtures, transformers and transformer enclosures on circuits operating at more than 150 volts to ground shall be grounded.

(2) Other exposed metal parts shall be grounded unless they are insulated from ground and other conducting surfaces and are inaccessible to unqualified persons, except that lamp tie wires, mounting screws, clips and decorative bands on glass lamps spaced not less than 1½ inches from lamp terminals need not be grounded.

E-410.95. Equipment Near Grounded Surfaces.

(1) Ungrounded metal lighting fixtures, lampholders and face plates shall not be installed in contact with conducting surfaces nor within 8 feet vertically or 5 feet horizontally of laundry tubs, bath tubs, shower baths, plumbing fixtures, steam pipes or other grounded metal work or grounded surfaces.

(2) Metal pull chains used at these locations shall be provided with insulating links.

E-410.96. Methods of Grounding.

Equipment shall be considered as grounded where mechanically connected in a permanent and effective manner to metal raceway, the armor of armored cable, the grounding conductor in non-metallic sheathed cable, or to a separate grounding conductor not smaller than No. 14, provided that the raceway, armor, or grounding conductor is grounded in a manner specified in Chapter E-250.

CHAPTER E-422

APPLIANCES

A. General

E-422.01. Scope.

This chapter shall apply to electric appliances used in any occupancy.

E-422.02. Branch Circuit Requirements.

Every appliance shall be supplied by a branch circuit of one of the types specified in Chapter E-210. Motor-operated appliances shall also conform to the requirements of Chapter E-430.

Note: See Table E-220.05 for the conductors of a household range branch circuit.

B. Installation of Appliances

E-422.03. Flexible Cords.

Flexible cords used to connect heating appliances shall comply with the following:

(1) Heater Cords Required. All smoothing irons and portable electrically-heated appliances rated at more than 50 watts and which produce temperatures in excess of 121°C (250°F) on surfaces with which the cord is liable to be in contact shall be provided with one of the types of approved heater cords listed in Table E-400.11.

(2) Other Heating Appliances. All other portable electrically-heated appliances shall be connected with one of the approved types of cord listed in Table E-400.11, selected in accordance with the usage specified in that Table.

E-422.04. Insulation of Appliances.

Portable appliances shall be provided with an adequate dielectric interposed between current-carrying parts and those external surfaces which persons can touch, except for toasters, grills or other heating appliances in which the current-carrying parts at high temperature are necessarily exposed. In locations where

the dielectric is exposed to physical damage, it shall be suitably protected.

E-422.05. Portable Immersion Heaters.

Electric heaters of the portable immersion type shall be so constructed and installed that current-carrying parts are effectively insulated from electrical contact with the substance in which immersed. The administrative authority may make exception of special applications of apparatus where suitable precautionary measures are followed.

E-422.06. Protection of Combustible Material.

Each electrically-heated appliance that is obviously intended by size, weight and service to be located in a fixed position shall be so placed as to provide ample protection between the appliance and adjacent combustible material.

E-422.07. Stands for Portable Appliances.

Each smoothing iron and other portable electrically-heated appliance which is intended to be applied to combustible material shall be equipped with an approved stand, which may be a separate piece of equipment or may be a part of the appliance.

E-422.08. Signals for Heated Appliances.

In other than residence occupancies, each electrically-heated appliance, or group of electrically-heated appliances, intended to be applied to combustible material, shall be installed in connection with a signal unless the appliance is provided with an integral temperature-limiting device.

E-422.09. Flatirons.

Electrically heated smoothing irons intended for use in residences shall be equipped with approved temperature-limiting means.

E-422.10. Water Heaters.

It is recommended that permanently-installed electrically-heated water heaters be equipped with temperature-limiting means.

E-422.11. Infra-Red Lamp Industrial Heating Appliances.

(1) Infra-red heating lamps rated at 300 watts or less may be used with lampholders of the medium-base unswitched porcelain type, or other types approved for the purpose.

(2) Screw-shell lampholders shall not be used with infra-red lamps over 300 watts rating unless the lampholders are especially approved for the purpose.

(3) Lampholders may be connected to any of the branch circuits of Chapter E-210 and, in industrial occupancies, may be operated in series on circuits of more than 150 volts to ground provided the voltage rating of the lampholders is not less than the circuit voltage.

Note: Each section, panel or strip carrying a number of infra-red lampholders (including the internal wiring of such section, panel or strip) is considered an appliance. The terminal connection block of each such assembly is deemed an individual outlet.

E-422.12. Grounding.

Metal frames of portable and stationary electrically-heated appliances, operating on circuits above 150 volts to ground, shall be grounded in the manner specified in Chapter E-250; provided, however, that where this is impracticable, grounding may be omitted by special permission, in which case the frames shall be permanently and effectively insulated from the ground.

Note: It is recommended that the frames be grounded in all cases. For methods of grounding frames of electric ranges and clothes dryers, see E-250.057 and E-250.060.

E-422.13. Wall-Mounted Ovens and Counter-Mounted Cooking Units.

(1) Wall-mounted ovens and counter-mounted cooking units complete with provisions for mounting and for making electrical connections shall be considered as fixed appliances.

(2) A separable connector or a plug and receptacle combination in the supply

line to an oven or cooking unit used only for ease in servicing or for installation shall:

(a) Not be installed as the disconnecting means required by E-422.14;

(b) Be approved for the temperature of the space in which it is located.

C. Control and Protection of Appliances

E-422.14. Disconnecting Means.

Each appliance shall be provided with a means for disconnection from all ungrounded conductors.

E-422.15. Disconnection of Portable Appliances.

(1) For portable appliances (including household ranges and clothes dryers) a separable connector or an attachment plug and receptacle may serve as the disconnecting means.

(2) The rating of a receptacle or of a separable connector shall not be less than the rating of any appliance connected thereto, except that demand factors authorized elsewhere in this Code may be applied.

(3) Attachment plugs and connectors shall conform to the following:

(a) Live Parts. They shall be so constructed and installed as to guard against inadvertent contact with live parts.

(b) Interrupting Capacity. They shall be capable of interrupting their rated current without hazard to the operator.

(c) Interchangeability. They shall be so designed that they will not fit into receptacles of lesser rating.

Note: For household electric ranges, a plug and receptacle connection at the rear base of a range, if it is accessible from the front by removal of a drawer, is considered as meeting the intent of this rule.

E-422.16. Disconnection of Stationary Appliances.

(1) For stationary appliances rated at not over 300 volt amperes or 1/8 horsepower, the branch-circuit overcurrent device may serve as the disconnecting

means.

(2) For stationary appliances of greater rating the branch-circuit switch or circuit-breaker may, where readily accessbile to the user of the appliance, serve as the disconnecting means.

E-422.17. Unit Switches as Disconnecting Means.

Switches which are a part of an appliance shall not be considered as taking the place of the single disconnecting means required by Part C of this Chapter, unless there are other means for disconnection as follows:

(1) Multi-Family Dwellings. In multi-family (more than two) dwellings, the disconnecting means shall be within the apartment, or on the same floor as the apartment in which the appliance is installed, and may control lamps and other appliances.

(2) Two-Family Dwellings. In two-family dwellings, the disconnecting means may be outside of the apartment in which the appliance is installed. This will permit an individual switch for the apartment to be used.

(3) Single-Family Dwellings. In single-family dwellings, the service disconnecting means may be used.

(4) Other Occupancies. In other occupancies, the branch-circuit switch or circuit-breaker, where readily accessible to the user of the appliance, may be used for this purpose.

E-422.18. Switch and Circuit-Breaker to be Indicating.

Switches and circuit-breakers used as disconnecting means shall be of the indicating type.

E-422.19. Motor-Driven Appliances.

A switch or circuit-breaker which serves as the disconnecting means for a stationary motor-driven appliance of more than 1/8 horsepower shall be located within sight of the motor controller or shall be capable of being locked in the open position.

E-422.20. Overcurrent Protection.

(1) Appliances, other than such motor-operated appliances as are required by Chapter E-430 to have additional overcurrent protection, shall be considered as protected against overcurrent when supplied by one of the circuits of Chapter E-210 and in accordance with the requirements therein specified.

(2) A range, hot plate or similar appliance with surface heating elements, having a maximum demand of more than 70 amperes, as calculated in accordance with Table E-220.05, shall have the main circuit subdivided into two or more circuits, each provided with overcurrent protection rated at not more than 50 amperes.

(3) Infra-red lamp heating appliances shall have overcurrent protection not exceeding 50 amperes.

D. Marking of Appliances.

E-422.21. Nameplate.

Each electric appliance shall be provided with a nameplate, giving the maker's name and the normal rating in volts and amperes, or in volts and watts.

E-422.22. Marking of Heating Elements.

Individual heating elements which are a part of an electric appliance containing more than one heating element shall each be legibly marked with normal rating in volts and amperes, or in volts and watts.

E. Special Provisions For Fixed Electrical Space Heating

E-422.23. General.

(1) Equipment for use with electrical space heating systems shall be of a type approved for such service.

(2) In addition to complying with the general requirements for appliances, such equipment shall comply with Part E of this Chapter.

(3) The special provisions of this Chapter shall apply to electrically energized units, panels and cables for space heating. They shall also include central heating systems employing electrical heating units.

(4) Electrical space heating systems employing methods of installation other than covered by Part E of this Chapter may be used only by special permission.

E-422.24. Use.

Space heating systems shall not be used:

(1) Where exposed to severe physical damage unless adequately protected.

(2) In wet or damp locations unless specially approved for the purpose.

Note: See also rules on Corrosive Conditions, E-310.07.

E-422.25. Temperature Limitations.

The operating temperature of room surfaces where embedded elements and panels are used shall not exceed 66°C. (150°F.). (Based on room temperature of 30°C., 86°F.)

Note: It is recommended that a temperature limiting control device be *

E-422.26. Appliances to Be Complete Units.

(1) Panels and cables shall be installed in their complete sizes or lengths as supplied by the manufacturer.

(2) Units which are shortened or from which the marking labels or nameplates are missing shall not be installed.

(3) Units shall be suitable for use with approved wiring systems.

E-422.27. Heating Cable Construction.

Heating cables shall be furnished complete with factory-assembled non-heating leads at least 7 feet in length, and the leads shall consist of conductors and wiring approved for general use or other wiring approved for the purpose.

E-422.28. Marking of Heating Cables.

(1) Each unit length of heating cable shall have a permanent marking located within 3 inches of the terminal end of the non-heating leads, and shall be legibly marked with the manufacturer's name or identification symbol, catalog number, and rating in volts and watts or amperes.

(2) The lead wires shall have the following color identifications: 230 volts nominal - red, 115 volts nominal - yellow.

* incorporated in each baseboard electric heater unit in a residential occupancy.

E-422.29. Controllers and Disconnecting Means.

(1) Thermostats and thermostatically controlled switching devices which indicate an "off" position and which interrupt line current shall open simultaneously all ungrounded conductors in the "off" position.

(2) Thermostats and thermostatically controlled switching devices which do not have "on" or "off" positions are not required to open all ungrounded conductors.

(3) Switching devices consisting of combined thermostats and manually controlled switches which serve both as controllers and disconneting means shall:

(a) Open regardless of temperature all ungrounded conductors when manually placed in the "off" position;

(b) Be so designed that the circuit cannot be energized automatically after the device has been manually placed in the "off" position.

Note: See E-422.14, E-422.16 and E-422.18 for disconnecting means for stationary appliances.

E-422.30. Clearances of Wiring in Ceilings.

(1) Wiring located above heated ceilings and within thermal insulation shall be spaced not less than 2 inches above the heated ceiling and shall be considered as operating at an ambient of 50°C. The current carrying capacities of conductors shall be computed on the basis of the correction factors given in Tables E-310.12 and E-310.14.

(2) Wiring located above heated ceilings and over thermal insulation having a minimum thickness of 2 inches requires no correction for temperature.

(3) Wiring located above heated ceilings and within a joist space having no thermal insulation shall be spaced not less than two inches above the ceiling and shall be considered as operating at an ambient of 50°C. The current carrying capacities of conductors shall be computed on the basis of the correction factors given in Tables E-310.12 and E-310.14.

E-422.31. Clearances of Wiring in Walls.

(1) Where located in exterior walls, wiring shall be located outside the thermal insulation.

(2) Where located in interior walls or partitions, wiring shall be located away from the heated surfaces, and the wiring shall be considered as operating at an ambient of 40°C (104°F); and the current carrying capacities of conductors shall be computed on the basis of the correction factors given in Tables E-310.12 and E-310.14.

E-422.32. Area Restrictions.

(1) Heating panels shall not extend beyond the room in which they originate.

(2) Cables shall not be installed in closets, over cabinets which extend to the ceiling, under walls or partitions or over walls or partitions which extend to the ceiling.

Exception: Single runs of cable may pass over partitions where they are embedded.

(3) This requirement shall not prohibit low-temperature heat sources in closets to control relative humidity.

E-422.33. Clearance from Other Objects and Openings.

Panels and cables shall be separated at least 8 inches from lighting fixtures, outlet and junction boxes, and 2 inches from ventilating openings and other such openings in room surfaces, or sufficient area shall be provided to assure that no heating cables or panels will be covered by surface mounted lighting units.

E-422.34. Splices.

Embedded cables may be spliced only where necessary and only by approved means, and in no case shall the length of the heating cable be altered.

E-422.35. Installation of Heating Cables in Dry Board and Plaster.

(1) Cables shall not be installed in walls.

(2) Adjacent runs of cable not exceeding 2 3/4 watts per foot shall be installed not less than 1½ inches on centers.

(3) Heating cables may be applied only to gypsum board, plaster lath and similar fire-resistant materials. With metal lath or other conducting surfaces, a coat of plaster (brown or scratch coat) shall be applied to completely cover the metal lath or conducting surface before the cable is attached.

(4) The entire ceiling surface shall have a finish of thermally non-insulating sand plaster or other approved non-insulating material having a nominal thickness of $\frac{1}{2}$ inch.

(5) Cables shall be secured at intervals not exceeding 16 inches by means of approved means. Staples or metal fasteners which straddle the cable shall not be used with metal lath or other conducting surface.

(6) In dry board installations, the entire ceiling shall be covered with gypsum board not exceeding $\frac{1}{2}$ inch thickness. The void between the upper layer of gypsum board and the surface layer of gypsum board shall be filled with thermally conducting plaster or other approved material.

(7) Cables shall be kept free from contact with metal or conducting surfaces.

(8) Caution should be used in attaching a surface layer of gypsum so that the nails or other fastenings do not pierce the heating cable.

E-422.36. Installation of Non-Heating Leads.

(1) Non-heating leads of cables shall be installed in accordance with approved wiring methods from the junction box to a location on the underside of the ceiling.

(2) Excess leads shall not be cut but shall be secured to the underside of the ceiling and embedded in plaster or other approved material, leaving only a length sufficient to reach the junction box with not less than 6 inches of free lead within the box.

(3) The marking of the leads shall be visible in the junction box.

E-422.37. Installation of Cables in Concrete or Poured Masonry Floors.

(1) Adjacent runs of cable not exceeding 2 3/4 watts per foot shall be installed not less than 1 inch on centers.

(2) Cables shall be secured in place by non-metallic frames or spreaders while

the concrete or other finish is applied.

(3) A spacing of at least 1 inch shall be maintained between the heating cable and other metallic bodies embedded in the floor.

(4) Leads shall be protected where they leave the floor by rigid metal conduit, electrical metallic tubing, or by other approved raceways extending to the junction box.

(5) Bushings shall be used where the leads emerge in the floor slab.

E-422.38. Tests During and After Installation.

(1) Embedded cable installations shall be made with due care to prevent damage to the cable assembly and shall be inspected and approved before cables are covered or concealed.

(2) Cable shall be tested for insulation resistance after plastering or the pouring of floors. See E-195.19, Insulation Resistance.

F. Provisions for Room Air-Conditioning Units

E-422.39. General.

The provisions of E-422.40 and E-422.41 shall apply to electrically energized units and equipment which control temperature and humidity.

E-422.40. Grounding.

Exposed non-current-carrying metal parts which are liable to become energized shall be grounded under one or more of the following conditions:

(1) Where permanently connected to metal-clad wiring;

(2) When in a wet location and not isolated;

(3) When within reach of a person standing on the ground outside of a building;

(4) When in a hazardous location, see Chapter E-500;

(5) Where in electrical contact with metal or metal lath;

(6) Where more than 150 volts to ground.

E-422.41. Branch Circuit Requirements.

(1) The total load of motor operated air-conditioning equipment shall not exceed 80 per cent of the rating of a branch circuit which does not supply lighting units or other appliances.

(2) The total load of air-conditioning equipment shall not exceed 50 per cent of the rating of a branch circuit where lighting units or other appliances are also supplied.

CHAPTER E-430

MOTORS, MOTOR CIRCUITS AND CONTROLLERS

NOTE: See Diagram Next Page for E-430.001

A. General

E-430.002. General.

The following general requirements cover provisions for motors, motor circuits, and controllers which do not properly fall into the other parts of this Chapter.

E-430.003. Sealed (Hermetic-Type) Refrigeration Compressor.

For the purposes of this Chapter, a sealed (hermetic-type) refrigeration compressor is a mechanical compressor consisting of a compressor and a motor, both of which are enclosed in the same housing, with no external shaft nor shaft seals, the motor operating in the refrigerant atmosphere.

E-430.004. In Sight From.

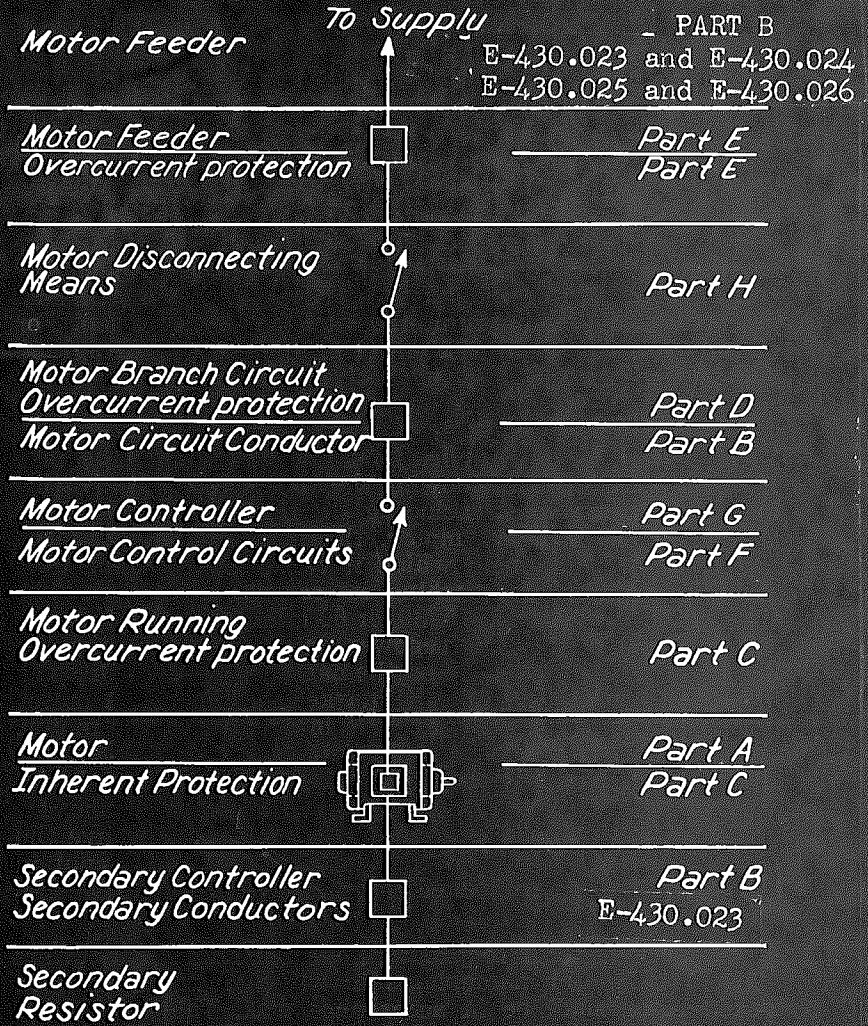
Where in this Chapter it is specified that some equipment shall be "in sight from" another equipment, it means that the equipment must be visible and not more than 50 feet distant.

E-430.005. Other Chapters.

Motors and controllers shall also comply with the applicable provisions of the following:

E-430.001. **Motor Feeder and Branch Circuits.**

General . . . . . Part A
Requirements for over 600 volts . . . . . Part J
Protection of live parts all voltages . . . . Part K
Grounding . . . . . Part L
Tables . . . . . Part M



E-430.006. Current-Carrying Capacity Determination.

Current-carrying capacities shall be determined as follows:

(1) General Motor Applications. Except as noted in E-430.006(2), whenever the current rating of a motor is used to determine the current-carrying capacity of conductors, switches, branch-circuit overcurrent devices, etc., the values given in Tables E-430.147, E-430.148, E-430.149, and E-430.150, including notes, shall be used instead of actual current rating marked on the motor nameplate. Motor running overcurrent protection shall be based on the motor nameplate current rating. When a motor is marked in amperes, but not horsepower, the horsepower rating shall be assumed to be that corresponding to the value given in Tables E-430.147, E-430.148, E-430.149, and E-430.150 interpolated if necessary.

(2) Sealed (Hermetic-Type) Refrigeration Compressor Motors. For sealed (hermetic-type) refrigeration compressor motors the full-load current marked on the nameplate for the compressor shall be used to determine the current-carrying capacity of the branch-circuit conductors (see E-430.022 and E-430.024), branch-circuit overcurrent protection, and motor-running overcurrent protection. For motor controllers and disconnecting means, see E-430.083, Exception No. 3, and E-430.110.

E-430.007. Marking On Motors.

(1) Usual Motor Applications. A motor shall be provided with a nameplate showing the maker's name, the rating in volts and amperes, including those of the secondary if a wound-rotor type of motor, the normal full-load speed and the interval during which it can operate at full load starting cold, before reaching its rated temperature. The time interval shall be 5, 15, 30, or 60 minutes, or continuous. A motor rated at 1/8 horsepower or larger shall have the horsepower rating marked on the nameplate except that the motors of arc welders may be marked in amperes. A motor provided with a protective device integral with the motor, that complies with E-430.032(1)(b) or E-430.032(3)(b) shall be permanently marked "Thermal Protection". An alternating-current motor rated at $\frac{1}{2}$ horsepower or larger, unless it is a polyphase wound-rotor motor, shall have the nameplate marked with a code letter to show

its input in kilovolt-amperes with locked rotor, selected from Table E-430.007(2).

(2) Locked Rotor Indicating Code Letters. Code letters marked on motor nameplates to show motor input with locked rotor shall be in accordance with Table E-430.007(2).

Table E-430.007(2). Locked Rotor Indicating Code Letters

Code Letter	Kilovolt-Amperes per Horsepower with Locked Rotor
A	0 - 3.14
B	3.15 - 3.54
C	3.55 - 3.99
D	4.0 - 4.49
E	4.5 - 4.99
F	5.0 - 5.59
G	5.6 - 6.29
H	6.3 - 7.09
J	7.1 - 7.99
K	8.0 - 8.99
L	9.0 - 9.99
M	10.0 - 11.19
N	11.2 - 12.49
P	12.5 - 13.99
R	14.0 - 15.99
S	16.0 - 17.99
T	18.0 - 19.99
U	20.0 - 22.39
V	22.4 - and up

Note 1. The above table is an adopted standard of the National Electrical Manufacturers Association.

Note 2. The code letter indicating motor input with locked rotor must be in an individual block on the nameplate, properly designated. This code letter is to be used for determining branch-circuit overcurrent protection by reference to Table E-430.152, as provided in E-430.052.

(3) Sealed (Hermetic-Type) Refrigeration Compressor Motors. Sealed (hermetic-type) refrigeration compressors shall be provided with a nameplate which shall give the manufacturer's name; the phase, voltage, frequency, and the full load current in

amperes of the motor (operating current when the compressor is delivering rated output). The locked-rotor current of single-phase motors having full load currents in amperes of more than 9 amperes at 115 volts and more than 4.5 amperes at 230 volts and all polyphase motors shall also be marked on the nameplate. When a protective device integral with a motor is used (see E-430.032), the nameplate shall be marked with the words "Thermal Protection".

E-430.008. Marking on Controllers.

A controller shall be marked with the maker's name or identification, the voltage, the current or horsepower rating, and such other data as may be needed to properly indicate the motors for which it is suitable.

Note: Where a controller is built in as an integral part of a motor or of a motor-generator set, the controller need not be individually marked when the necessary data is on the motor nameplate.

E-430.009. Marking at Terminals.

Terminals of motors and controllers shall be suitably marked or colored where necessary to indicate the proper connections.

E-430.010. Wiring Space in Enclosures.

Enclosures for controllers and disconnecting means for motors shall not be used as junction boxes, auxiliary gutters, or raceways for conductors feeding through or tapping off to other apparatus unless designs are employed which provide adequate space for this purpose.

E-430.011. Protection Against Liquids.

Suitable guards or enclosures shall be provided to protect exposed current-carrying parts of motors and the insulation of motor leads where installed directly under equipment, or in other locations where dripping or spraying oil, water, or other injurious liquid may occur, unless the motor is designed for the existing conditions.

E-430.012. Motor Terminal Housings.

Motor terminal housings shall be of ample size to properly make connections

and shall be of substantial metal construction.

E-430.013. Bushings.

Soft-rubber bushings used to protect lead wires where they pass through the frame of a motor shall not be exposed to oils, grease, oily vapors, or other substances having a deleterious effect on rubber.

Note: For conductors, see E-310.07.

E-430.014. Location of Motors.

(1) Ventilation and Maintenance. Motors shall be located so that adequate ventilation is provided and so that maintenance such as lubrication of bearings and replacing of brushes can be readily accomplished.

(2) Open Motors. Open motors having commutators or collector rings shall be located or protected so that sparks cannot reach adjacent combustible material. This does not prohibit the installation of these motors on wooden floors or supports.

E-430.016. Overheating From Dust Accumulations.

In locations where dust or flying material will collect on or in motors in such quantities as to seriously interfere with the ventilation or cooling of motors, and thereby cause dangerous temperatures, suitable types of enclosed motors which will not overheat under the prevailing conditions, shall be used. Especially severe conditions may require the use of enclosed pipe ventilated motors, or enclosure in separate dust-tight rooms, properly ventilated from a source of clean air.

B. Motor Circuit Conductors

E-430.021. General.

The provisions of Part B specify sizes of conductors capable of carrying the motor current without overheating under the conditions specified.

E-430.022. Single Motor.

(1) Branch-circuit conductors supplying a single motor shall have a carrying capacity not less than 125 per cent of the motor full-load current rating.

Note 1. Any motor application is considered to be for continuous duty unless

the nature of the apparatus which it drives is such that the motor will not operate continuously with load under any condition of use.

Note 2. For long runs, it may be necessary in order to avoid excessive voltage drop, to use conductors of sizes larger than the minimum sizes selected from Tables E-310.12 to E-310.15 inclusive.

Note 3. See diagram E-430.001, and Example No. 8, Chapter E-900.

Exception: Conductors for a motor used for short-time, intermittent, periodic, or varying duty may have a carrying capacity not less than the percentage of the motor nameplate current rating as shown in Table E-430.022 ((1) Exception) unless the administrative authority grants special permission for conductors of smaller size.

(2) The conductors between a stationary motor rated one horsepower or less, and the separate terminal enclosures permitted in E-430.145(2) may be smaller than No. 14 but not smaller than No. 18, provided they have current-carrying capacity as specified above.

Table E-430.022 ((1) - Exception)

Classification of Service	Percentages of Nameplate Current Rating			
	5-Minute Rated Motor	15-Minute Rated Motor	30 & 60 Minute Rated Motor	Continuous Rated Motor
Short-Time Duty				
Operating valves, raising or lowering rolls, etc.	110	120	150	...
Intermittent Duty				
Freight and passenger elevators, tool heads, pumps, drawbridges, turntables, single-operator arc welders for manual welding, etc.	85	85	90*	140
Periodic Duty				
Rolls, ore and coal-handling machines, etc.	85	90	95	140
Varying Duty	110	120	150	200

*This figure also applies for conductors which supply a motor-generator single-operator arc welder which has a 60 per cent duty cycle rating.

E-430.023. Wound-Rotor Secondary.

For continuous duty the conductors connecting the secondary of a wound-rotor alternating-current motor to its controller shall have a carrying capacity which is not less than 125 per cent of the full-load secondary current of the motor.

Exception: (1) For other than continuous duty, these conductors shall have a carrying capacity, in per cent of full-load secondary current, not less than that specified in Table E-430.022 ((1) - Exception).

(2) Where the secondary resistor is separate from the controller, the carrying capacity of the conductors between controller and resistor shall be not less than that given in Table E-430.023 (Exception).

Table E-430.023 (Exception)

Resistor Duty Classification	Carrying Capacity of Wire in Per Cent of Full-Load Secondary Current
Light starting duty	35
Heavy starting duty	45
Extra heavy starting duty	55
Light intermittent duty	65
Medium intermittent duty	75
Heavy intermittent duty	85
Continuous duty	110

E-430.024. Conductors Supplying Several Motors.

Conductors supplying two or more motors shall have a current-carrying capacity of not less than 125 per cent of the full-load current rating of the highest rated motor in the group plus the sum of the full-load current ratings of the remainder of the motors in the group.

Note: See Example No. 8, Chapter E-900.

E-430.025. Combination Load. Conductors supplying a motor load, and in addition a lighting or appliance load as computed from Chapter E-220 and other applicable rules, shall have a current-carrying capacity sufficient for the lighting or appliance load plus the required capacity for the motor load determined in accordance with

E-430.024, or, for a single motor, in accordance with E-430.022.

E-430.026. Feeder Demand-Factor.

Where a reduced heating of the conductors results from motors operating on duty-cycle, intermittently, or from all motors not operating at one time the administrative authority may grant permission for feeder conductors to be of a capacity less than specified in E-430.024 and E-430.025, provided the conductor is of sufficient carrying capacity for the maximum load determined by the sizes and number of motors supplied and the character of their loads and duties.

E-430.027. Capacitors with Motors.

For provisions covering conductors where capacitors are installed on motor circuits, see E-460.07, E-460.08 and E-460.09.

C. Motor Running Overcurrent (Overload) Protection

E-430.031. General.

The provisions of Part C specify overcurrent devices intended to protect the motors, the motor-control apparatus, and the branch-circuit conductors against excessive heating due to motor overloads.

(1) Overload in electrical apparatus is an operating overcurrent which, when it persists for a sufficient length of time, would cause damage or dangerous overheating of the apparatus. It does not include short-circuits or ground faults.

(2) These provisions shall not be interpreted as requiring overcurrent protection where it might introduce additional or increased hazards as in the case of fire pumps (see NFPA Standard for Centrifugal Fire Pumps (No. 20)).

E-430.032. Continuous Duty Motors.

(1) More Than One Horsepower. Each continuous duty motor rated more than one horsepower shall be protected against running overcurrent by one of the following means:

(a) A separate overcurrent device which is responsive to motor current. This device shall be rated or selected to trip at not more than 125 per cent of the

motor full-load current rating for sealed (hermetic-type) refrigeration compressor motors and motors marked to have a temperature rise not over 40°C, and at not more than 115 per cent for all other types of motors. This value may be modified as permitted by E-430.034.

(b) A thermal protector integral with the motor, approved for use with the motor which it protects on the basis that it will prevent dangerous overheating of the motor due to overload or failure to start. If the motor current interrupting device is separate from the motor and its control circuit is operated by a protective device integral with the motor, it shall be so arranged that the opening of the control circuit will result in interruption of current to the motor.

(c) For motors larger than 1500 horsepower, a protective device employing embedded temperature detectors which cause current to the motor to be interrupted when the motor attains a temperature rise greater than marked on the nameplate in an ambient of 40°C.

Note: Standards for the application of embedded temperature detectors are given in the American Standards for Rotating Machinery, ASA C-50 (paragraph 3.080).

(2) One Horsepower or Less, Manually Started. Each continuous duty motor rated at one horsepower or less which is not permanently installed, is manually started and is within sight from the controller location, shall be considered as protected against overcurrent by the overcurrent device protecting the conductors of the branch circuit. This branch circuit overcurrent device shall not be larger than that specified in Table E-430.146, except that any such motor may be used at 125 volts or less on a branch circuit protected at 20 amperes. Any such motor which is not in sight from the controller location shall be protected as specified in E-430.032(3). Any motor rated at one horsepower or less which is permanently installed, shall be protected in accordance with E-430.032(3).

(3) One Horsepower or Less, Automatically Started. Any motor of one horsepower or less which is started automatically shall be protected against overcurrent by the use of one of the following means:

(a) A separate overcurrent device which is responsive to motor current. This device shall be rated or selected to trip at not more than 125 per cent of the motor full-load current rating for sealed (hermetic-type) refrigeration compressor motors and motors marked to have a temperature rise not over 40°C, and at not more than 115 per cent for all other types of motors. This value may be modified as permitted by E-430.034.

(b) A thermal protector integral with the motor, approved for use with the motor which it protects on the basis that it will prevent dangerous overheating of the motor due to overload or failure to start. Where the motor current interrupting device is separate from the motor and its control circuit is operated by a protective device integral with the motor, it shall be so arranged that the opening of the control circuit will result in interruption of current to the motor.

(c) The motor shall be considered as being properly protected where it is part of an approved assembly which does not normally subject the motor to overloads and which is also equipped with other safety controls (such as the safety combustion controls of a domestic oil burner) which protect the motor against damage due to stalled rotor current. Where such protective equipment is used it shall be indicated on the nameplate of the assembly where it will be visible after installation.

(d) 1. In case the impedance of the motor windings is sufficient to prevent overheating due to failure to start, the motor may be protected as specified in E-430.032(2) for manually started motors.

2. Many alternating-current motors of less than 1/20 horsepower, such as clock motors, series motors, etc., and also some larger motors such as torque motors, come within this classification. It does not include split-phase motors having automatic switches to disconnect the starting windings.

(4) Wound-Rotor Secondaries. The secondary circuits of wound-rotor alternating-current motors, including conductors, controllers, resistors, etc., shall be considered as protected against overcurrent by the motor-running over-current

device.

E-430.033. Intermittent and Similar Duty.

A motor used for a condition of service which is inherently short time, intermittent, periodic, or varying duty, as illustrated by Table E-430.022((1)-Exception), is considered as protected against overcurrent by the branch-circuit overcurrent device, provided the overcurrent protection does not exceed that specified in Tables E-430.152 and E-430.153.

Note: Any motor application is considered to be for continuous duty unless the nature of the apparatus which it drives is such that the motor cannot operate continuously with load under any condition of use.

E-430.034. Selection or Setting of Protective Device.

(1) Where the values specified for motor-running overcurrent protection do not correspond to the standard sizes or ratings of fuses, non-adjustable circuit-breakers, thermal cut-outs, thermal relays, the heating elements of thermal trip motor switches, or possible settings of adjustable circuit-breakers adequate to carry the load, the next higher size, rating, or setting may be used, but not higher than 140 per cent of the full-load current rating of sealed (hermetic-type) refrigeration compressor motors and motors marked to have a temperature rise not over 40°C, and not higher than 130 per cent of the full-load current rating for all other motors.

(2) In case it is not shunted during the starting period of the motor (see E-430.035), the protective device shall have sufficient time delay to permit the motor to start and accelerate its load.

E-430.035. Shunting During Starting Period.

(1) In the case of a motor that is manually started (including starting with a magnetic starter having push-button control), the running overcurrent protection may be shunted or cut out of circuit during the starting period of the motor, provided the device by which the overcurrent protection is shunted or cut out

cannot be left in the starting position, and fuses or time-delay circuit-breakers rated or set at not over 400 per cent of the full-load current of the motor, are so located in the circuit as to be operative during the starting period of the motor.

(2) The motor-running overcurrent protection shall not be shunted or cut out during the starting period if the motor is automatically started.

E-430.036. Fuses - In Which Conductor.

Where fuses are used for motor-running protection, a fuse shall be inserted in each ungrounded conductor.

Exception: A fuse shall also be inserted in a grounded conductor under the circumstances set forth in the note following Table E-430.037 for circuits supplied by wye-delta or delta-wye connected transformers.

E-430.037. Devices Other Than Fuses - In Which Conductor.

Where devices other than fuses are used for motor-running overload protection, Table E-430.037 shall govern the minimum allowable number and location of overcurrent units such as trip coils, relays, or thermal cutouts.

E-430.038. Number of Conductors Opened by Overcurrent Device.

Motor-running protective devices, other than fuses, thermal cutouts, or thermal protectors, shall simultaneously open a sufficient number of ungrounded conductors to interrupt current flow to the motor.

E-430.039. Motor Controller as Running Overcurrent Protection.

A motor controller may also serve as the running overcurrent device where the number of overcurrent units complies with E-430.037 and where these overcurrent units are operative in both the starting and running position in the case of a direct-current motor, and in the running position in the case of an alternating-current motor. When a non-automatic motor controller serves as the running overcurrent device, it is recommended that all ungrounded conductors be opened.

Table E-430.037

Kind of Motor	Supply System	Number and location of over-current units, such as trip coils, relays or thermal cutouts
1-phase A.C. or D.C.	2-wire, 1-phase A.C. or D.C. ungrounded	1 in either conductor
1-phase A.C. or D.C.	2-wire, 1-phase A.C. or D.C., one conductor grounded	1 in ungrounded conductor
1-phase A.C. or D.C.	3-wire, 1-phase A.C. or D. C., grounded-neutral	1 in either ungrounded conductor
2-phase A.C.	3-wire, 2-phase A.C., ungrounded	2, one in each phase
2-phase A.C.	3-wire, 2-phase A.C., one conductor grounded	2 in ungrounded conductors
2-phase A.C.	4-wire, 2-phase A.C. grounded or ungrounded	2, one per phase in ungrounded conductors
2-phase A.C.	5-wire, 2-phase A.C., grounded-neutral or ungrounded	2, one per phase in any ungrounded phase wir
3-phase A.C.	3-wire, 3-phase A.C., ungrounded	*2 in any 2 conductors
3-phase A.C.	3-wire, 3-phase A.C., one conductor grounded	*2 in ungrounded conductors
3-phase A.C.	3-wire, 3-phase A.C. grounded-neutral	*2 in any 2 conductors
3-phase A.C.	4-wire, 3-phase A.C. grounded-neutral or ungrounded	*2 in any 2 conductors except the neutral

*Note: Three running overcurrent units shall be used where three-phase motors are installed in isolated, inaccessible, or unattended locations unless the motor is protected by other approved means.

E-430.040. Thermal Cutouts and Relays.

Thermal cutouts, thermal relays, and other devices for motor-running protection which are not capable of opening short-circuits, shall be protected by fuses

or circuit-breakers with ratings or settings of not over 4 times the rating of the motor for which they are designed, unless approved for group installation, and marked to indicate the maximum size of fuse by which they must be protected.

E-430.041. Motors on General Purpose Branch Circuits.

Overcurrent protection for motors used on general purpose branch circuits as permitted in Chapter E-210, shall be provided as follows:

(1) One or more motors without individual running over-current protection may be connected to general purpose branch-circuits only where the limiting conditions specified for each of two or more motors in E-430.053(1) are complied with.

(2) Motors of larger ratings than specified in E-430.053(1) may be connected to general purpose branch-circuits only in case each motor is protected by running over-current protection selected to protect the motor as specified in E-430.032. Both the controller and the motor-running overcurrent device shall be approved for group installation with the protective device of the branch circuit to which the motor is connected. See E-430.053.

(3) Where a motor is connected to a branch circuit by means of a plug and receptacle, and individual running overcurrent protection is omitted as provided in E-430.041(1), the rating of the plug and receptacle shall not exceed 15 amperes at 125 volts or 10 amperes at 250 volts. Where individual overcurrent protection is required as provided in E-430.041(2) for a motor or motor-operated appliance provided with an attachment plug for attaching to the branch circuit through a receptacle, the running over-current device shall be an integral part of the motor or of the appliance. The rating of the plug and receptacle shall be assumed to determine the rating of the circuit to which the motor may be connected, as provided in Chapter E-210.

(4) The overcurrent device protecting a branch circuit to which a motor or motor-operated appliance is connected shall have sufficient time delay to permit the motor to start and accelerate its load.

E-430.049. Automatic Restarting.

A motor-running protective device which can restart a motor automatically after overcurrent tripping shall not be installed unless approved for use with the motor which it protects. A motor which can restart automatically after shutdown shall not be installed so that its automatic restarting can result in injury to persons.

D. Motor-Branch-Circuit Short Circuit and Ground Fault Protection

E-430.051. General.

The provisions of Part D specify overcurrent devices intended to protect the motor-branch-circuit conductors, the motor control apparatus, and the motors against overcurrent due to short-circuits or grounds. They are in addition to or amendatory of the provisions of Chapter E-240.

E-430.052. Rating or Setting for Individual Motor Circuit.

The motor-branch-circuit overcurrent device shall be capable of carrying the starting current of the motor. Overcurrent protection shall be considered as being obtained when this overcurrent device has a rating or setting not exceeding the values given in Table E-430.152 or E-430.153; provided that where the overcurrent protection specified in the Table is not sufficient for the starting current of the motor, it may be increased, but shall in no case exceed 400 per cent of the motor full-load current.

Branch circuit protective device ratings

Note 1. [illegible] / calculated on this basis are given in columns 4, 5, 6 and 7 of Table E-430.146.

Note 2. See Diagram in E-430.001, and Example No. 8, Chapter E-900.

E-430.053. Several Motors on One Branch Circuit.

Two or more motors may be connected to the same branch circuit under the

following conditions:

(1) Two or more motors each not exceeding one horsepower in rating and each having a full-load rated capacity not exceeding 6 amperes, may be used on a branch circuit protected at not more than 20 amperes at 125 volts or less, or 15 amperes at 600 volts or less. Individual running overcurrent protection is unnecessary for such motors unless required by the provisions of E-430.032.

(2) Two or more motors of any ratings, each having individual running overcurrent protection, may be connected to one branch circuit provided all of the following conditions are complied with:

(a) Each motor-running overcurrent device must be approved for group installation.

(b) Each motor controller must be approved for group installation.

(c) The branch circuit must be protected by fuses having a rating equal to that specified in E-430.052 for the largest motor connected to the branch circuit plus an amount equal to the sum of the full load current ratings of all other motors connected to the circuit.

(d) The branch circuit fuses must not be larger than allowed by E-430.040 for the thermal cutout or relay protecting the smallest motor of the group.

(e) The conductors of any tap supplying a single motor need not have individual branch circuit protection, provided they comply with either of the following: (1) no conductor to the motor shall have a current-carrying capacity less than that of the branch circuit conductors, or (2) no conductor to the motor shall have a current-carrying capacity less than one-third that of the branch circuit conductors, with a minimum in accordance with E-430.022; the conductors to the motor-running protective device being not more than 25 feet long and being protected from physical damage.

E-430.054. Combined Overcurrent Protection.

Motor-branch-circuit overcurrent protection and motor-running overcurrent protection may be combined in a single overcurrent device when the rating or setting of the device provides the running overcurrent protection specified in E-430.032.

E-430.055. Overcurrent Devices - In Which Conductor.

Overcurrent devices shall comply with the provisions of E-240.11.

E-430.056. Size of Fuseholder.

Where fuses are used for motor-branch-circuit protection, the fuse-holders shall not be of a smaller size than required to accommodate the fuses specified by Table E-430.146.

Exception: Where fuses having time delay appropriate for the starting characteristics of the motor are used, fuseholders of smaller size than specified in Table E-430.146 may be used.

E-430.057. Rating of Circuit-Breaker.

A circuit-breaker for motor-branch circuit protection shall have a continuous current rating of not less than 115 per cent of the full load current rating of the motor.

E-430.058. Feeder Taps in Inaccessible Location.

If the location of the connection of a tap to the feeder conductors is not accessible, the motor-branch-circuit overcurrent device may be placed where it will be accessible, provided the conductors between the tap and the overcurrent device have the same current-carrying capacity as the feeder; or provided they have a current-carrying capacity of at least 1/3 that of the feeder and are not more than 25 feet long (where feeders are at a greater elevation, this distance may be increased to 50 feet) and are protected from physical damage.

E-430.059. Selection or Setting of Protective Device.

In case the values for branch circuit protective devices determined by Table E-430.152 or E-430.153 do not correspond to the standard sizes or ratings of fuses, non-adjustable circuit-breakers, or thermal devices, or possible settings of adjust-

able circuit-breakers adequate to carry the load, the next higher size, rating or setting may be used. (See E-240.06 and E-240.07 for Standard Ratings.)

E. Motor-Feeder Short-Circuit and Ground Fault Protection

E-430.061. General.

The provisions of Part E specify overcurrent devices intended to protect feeder conductors supplying motors against overcurrents due to short-circuits or grounds.

E-430.062. Rating or Setting - Motor Load.

(1) A feeder which supplies a specific fixed motor load and consisting of conductor sizes based on E-430.024 shall be provided with overcurrent protection which shall not be greater than the largest rating or setting of the branch-circuit protective device, for any motor of the group (based on Tables E-430.152 and E-430.153), plus the sum of the full-load currents of the other motors of the group.

Note 1. Where two or more motors of equal horsepower rating are the largest in the group, one of these motors should be considered as the largest for the above calculations.

Note 2. Where two or more motors of a group must be started simultaneously, it may be necessary to install larger feeder conductors and correspondingly larger ratings or settings of feeder overcurrent protection.

Note 3. See Example 8, Chapter E-900.

(2) For large capacity installations, where heavy capacity feeders are installed to provide for future additions or changes, the feeder overcurrent protection may be based on the rated current-carrying capacity of the feeder conductors.

E-430.063. Rating or Setting - Power and Light Loads.

Where a feeder supplies a motor load, and in addition a lighting or a lighting and appliance load, the feeder overcurrent protective device may have a rating or setting sufficient to carry the lighting or the lighting and appliance load as

determined in accordance with Chapters E-210 and E-220 plus, for a single motor, the rating permitted by E-430.052, and for two or more motors, the rating permitted by E-430.062.

F. Motor-Control Circuits

E-430.071. General.

Part F contains modifications of the general requirements and applies to the particular conditions of motor control circuits.

Note: Control Circuits (Definition) - The control circuit of a control apparatus or system is the circuit which does not carry the main load current, and by means of which the electric signals directing the performance of the controller are transmitted.

E-430.072. Overcurrent Protection.

Conductors of control circuits shall be protected against overcurrent in accordance with E-240.05, Exception No. 5.

Exception. Such conductors shall be considered as being properly protected by the branch-circuit overcurrent devices under any one of the following conditions:

(1) Where the rating or setting of the branch-circuit overcurrent device is not more than 500 per cent of the carrying capacity of the control-circuit conductors.

(2) Where the controlled device and the point of control (start and stop buttons, pressure switch, thermostatic switch, etc.) are both located on the same machine and the control circuit does not extend beyond the machine.

(3) Where the opening of the control circuit would create a hazard; as for example, the control circuit of fire-pump motors, and the like.

E-430.073. Mechanical Protection of Conductor.

Where damage to a control circuit would constitute a hazard, all conductors of such remote-control circuit shall be installed in a raceway or be otherwise suitably protected from physical damage outside the control device itself.

Note: It is recommended that control circuits be so arranged that an accidental ground will not start the motor.

E-430.074. Disconnection.

(1) Control circuits shall be so arranged that they will be disconnected from all sources of supply when the disconnecting means is in the open position. The disconnecting means may consist of two separate devices, one of which disconnects the motor and the controller from the source of power supply for the motor, and the other, the control circuit from its power supply. Where the two separate devices are used, they should be located immediately adjacent one to the other.

(2) Where a transformer or other device is used to obtain a reduced voltage for the control circuit and is located in the controller, such transformer or other device shall be connected to the load side of the disconnecting means for the control circuit.

G. Motor Controllers

E-430.081. General.

The provisions of Part G are intended to require suitable controllers for all motors.

(1) Definition. For definition of "Controller", see Chapter E-100. For the purpose of this Chapter, the term "Controller" includes any switch or device normally used to start and stop the motor.

(2) Stationary Motor of 1/8 Horsepower or Less. For a stationary motor rated at 1/8 horsepower or less, that is normally left running and is so constructed that it cannot be damaged by overload or failure to start, such as clock motors and the like, the branch circuit overcurrent device may serve as the controller.

(3) Portable Motor of 1/3 Horsepower or Less. For a portable motor rated at 1/3 horsepower or less, the controller may be an attachment plug and receptacle.

E-430.082. Controller Design.

(1) Controller. Each controller shall be capable of starting and stopping the motor which it controls, and for an alternating-current motor shall be capable

of interrupting the stalled-rotor current of the motor.

(2) Auto-Transformer. An auto-transformer starter shall provide an off position, a running position, and at least one starting position. It shall be so designed that it cannot rest in the starting position, or in any position which will render inoperative the overcurrent protective device in the circuit.

(3) Rheostats. Rheostats shall conform to the following:

(a) Internal Connections. Motor-starting rheostats shall be so designed that the contact arm cannot be left on intermediate segments. The point or plate on which the arm rests when in the starting position shall have no electrical connection with the resistor.

(b) Under-Voltage Release, Direct-Current Motors. Motor-starting rheostats for direct-current motors shall be equipped with automatic devices which will interrupt the supply before the speed of the motor has fallen to less than one-third its normal value.

E-430.083. Rating.

The controller shall have a horsepower rating, which shall not be lower than the horsepower rating of the motor, except as follows:

Exception No. 1.

Stationary Motor of 2 Horsepower or Less. For a stationary motor rated at 2 horsepower or less, and 300 volts or less, the controller may be a general-use switch having an ampere rating at least twice the full-load current rating of the motor. On AC circuits, general use snap switches suitable only for use on AC (not general use AC-DC snap switches) may be used to control a motor having a full-load current rating not exceeding 80 per cent of the ampere rating of the switch.

Exception No. 2. Circuit-Breaker as Controller. A branch-circuit circuit-breaker, rated in amperes only, may be used as a controller. Where this circuit-breaker is also used for overcurrent protection, it shall conform to the appropriate

provisions of this Chapter governing overcurrent protection.

Exception No. 3. Sealed (Hermetic-type) Refrigeration Compressor Motors. The motor controller shall have both a continuous duty full-load current rating, and a locked-rotor current rating, not less than the nameplate full-load current and locked-rotor current, respectively, of the compressor. In case the motor controller is rated in horsepower, but is without one or both of the foregoing current ratings, equivalent currents shall be determined from the rating as follows: Use Table E-430.148, E-430.149, or E-430.150 to determine the equivalent full-load current rating. Use Table E-430.151 to determine the equivalent locked-rotor current rating.

E-430.084. Need Not Open All Conductors.

Except when it serves also as a disconnecting means (see E-430.111), the controller need not open all conductors to the motor.

E-430.085. In Grounded Conductors.

One pole of the controller may be placed in a permanently grounded conductor provided the controller is so designed that the pole in the grounded conductor cannot be opened without simultaneously opening all conductors of the circuit.

E-430.086. Motor Not in Sight From Controller.

Where a motor and the driven machinery are not in sight from the controller location, the controller shall comply with one of the following conditions:

(1) The controller or its disconnecting means is capable of being locked in the open position, unless special permission is given by the administrative authority.

(2) A manually-operable switch, which will prevent the starting of the motor, is placed within sight from the motor location. This switch may be placed in the control circuit of the magnetic controller.

(3) As otherwise specified in Chapters E-500 to E-517 of this Code.

E-430.087. Number of Motors Served by Each Controller.

Each motor shall be provided with an individual controller.

Exception: For motors of 600 volts or less a single controller may serve a group of motors under any one of the following conditions:

(1) Where a number of motors drive several parts of a single machine or piece of apparatus such as metal and wood-working machines, cranes, hoists, and similar apparatus.

(2) Where a group of motors is under the protection of one overcurrent device as permitted in E-430.053(1).

(3) Where a group of motors is located in a single room within sight from the controller location.

E-430.088. Adjustable-Speed Motors.

Adjustable-speed motors that are controlled by means of field regulation shall be so equipped and connected that they cannot be started under weakened field, unless the motor is designed for such starting.

E-430.089. Speed Limitation.

Machines of the following types shall be provided with speed limiting devices.

(1) Separately-excited direct-current motors.

(2) Series motors.

(3) Motor-generators and converters which can be driven at excessive speed from the direct-current end, as by a reversal of current or decrease in load.

Exception No. 1. Unless the inherent characteristics of the machines, the system, or the load and the mechanical connection thereto, are such as to safely limit the speed.

Exception No. 2. Unless the machine is always under the manual control of a qualified operator.

E-430.090. Combination Fuseholder and Switch as Controller.

The rating of a combination fuseholder and switch used as a motor-controller

shall be such that the fuseholder will accommodate the size of fuse specified in Table E-430.146, for motor-running overcurrent protection.

Exception: Where fuses having time delay appropriate for the starting characteristics of the motor are used, fuseholders of smaller size than specified in Table E-430.146 may be used.

H. Disconnecting Means

E-430.101. General.

The provisions of Part H are intended to require disconnecting means capable of disconnecting motors and controllers from the circuit.

Note: See Diagram E-430.001.

E-430.102. In Sight from Controller Location.

The disconnecting means shall be located in sight from the controller location or be arranged to be locked in the open position.

E-430.103. To Disconnect Both Motor and Controller.

The disconnecting means shall disconnect both the motor and the controller from all ungrounded supply conductors. The disconnecting means may be in the same enclosure with the controller.

E-430.104. To Be Indicating.

The disconnecting means shall plainly indicate whether it is in the open or closed position.

E-430.105. Grounded Conductors.

One pole of the disconnecting means may disconnect a permanently grounded conductor, provided the disconnecting means is so designed that the pole in the grounded conductor cannot be opened without simultaneously disconnecting all conductors of the circuit.

E-430.106. Service Switch as Disconnecting Means.

Where an installation consists of a single motor, the service switch may serve as the disconnecting means, provided it conforms to the requirements of this Chapter, and is within sight from the controller location or is arranged to be locked

in an open position.

E-430.107. Readily Accessible.

The disconnecting means shall be readily accessible.

E-430.108. Every Switch.

Every switch in the motor branch circuit within sight from the controller location shall comply with the requirements of Part H.

E-430.109. Type.

The disconnecting means shall be a motor-circuit switch, rated in horsepower, or a circuit-breaker, except as permitted in E-430.109(1), (2), (3), (4), or (5).

(1) One-Eighth Horsepower or Less. For stationary motors of 1/8 horsepower or less, the branch-circuit overcurrent device may serve as the disconnecting means.

(2) Two Horsepower or Less.

For stationary motors rated at 2 horsepower or less and 300 volts or less, the disconnecting means may be a general-use switch having an ampere rating not less than twice the full-load current rating of the motor. On AC circuits, general use snap switches suitable only for use on AC (not general use AC-DC snap switches) may be used to disconnect a motor having a full-load current rating not exceeding 80 per cent of the ampere rating of the switch.

(3) Over Two Horsepower to and Including 50 Horsepower. The separate disconnecting means required for a motor with an auto-transformer type of controller may be a general-use switch where all of the following provisions are complied with:

(a) The motor drives a generator which is provided with overcurrent protection.

(b) The controller 1. is capable of interrupting the stalled-rotor current of the motor, 2. is provided with a no-voltage release, and 3. is provided with running-overcurrent protection not exceeding 125 per cent of the motor

full-load current rating.

(c) Separate fuses or a circuit-breaker, rated or set at not more than 150 per cent of the motor full-load current, are provided in the motor branch circuit.

(4) Exceeding 50 Horsepower.

(a) For stationary motors rated at more than 50 horsepower, the disconnecting means may be a motor-circuit switch also rated in amperes, a general-use switch, or an isolating switch.

(b) Isolation switches for motors exceeding 50 horsepower, not capable of interrupting stalled-rotor currents, shall be plainly marked "Do not open under load".

(5) Portable Motors. For portable motors an attachment plug and receptacle may serve as the disconnecting means.

E-430.110. Carrying Capacity and Interrupting Capacity.

(1) The disconnecting means shall have a carrying capacity of at least 115 per cent of the current rating of the motor as determined from Tables E-430.147, E-430.148, E-430.149, and E-430.150.

(2) The disconnecting means for sealed (hermetic-type) refrigeration compressors shall be selected on the basis of the nameplate full-load current and locked-rotor current respectively of the compressor motor as follows:

(a) The carrying capacity shall be at least 115 per cent of the nameplate full-load current.

(b) To determine the equivalent horsepower in complying with the requirements of E-430.109, select the horsepower rating from Tables E-430.148, E-430.149, and E-430.150 corresponding to the full-load current, and also the horsepower rating from Table E-430.151 corresponding to the locked-rotor current. In case the nameplate full-load current and locked-rotor current do not correspond to the currents shown in Tables E-430.148, E-430.149, and E-430.150, respectively, the horsepower rating corresponding to the next higher value shall be selected. In case two

different horsepower ratings are obtained when applying Tables E-430.148, E-430.149, and E-430.150 and Table E-430.151, a horsepower rating at least equal to the larger of the two values obtained shall be selected.

E-430.111. Switch or Circuit-Breaker as Both Controller and Disconnecting Means.

(1) A switch or circuit-breaker complying with the provisions of E-430.083 may serve as both controller and disconnecting means provided it opens all ungrounded conductors to the motor, is protected by an overcurrent device (which may be the branch circuit fuses) which opens all ungrounded conductors to the switch or circuit-breaker, and is of one of the following types:

(a) An air-break switch, operable directly by applying the hand to a lever or handle.

(b) A circuit-breaker operable directly by applying the hand to a lever or handle.

(c) An oil switch used on a circuit whose rating does not exceed 600 volts or 100 amperes, or by special permission on a circuit exceeding this capacity where under expert supervision.

(2) The oil switch or circuit-breaker specified above may be both power and manually operable. If power operable, provision should be made to lock it in the open position.

(3) The overcurrent device protecting the controller may be part of the controller assembly or may be separate.

(4) An autotransformer type of controller is not included above and will require a separate disconnecting means.

E-430.112. Motors Served by a Single Disconnecting Means.

(1) Each motor shall be provided with individual disconnecting means.

Exception: For motors of 600 volts or less a single disconnecting means may serve a group of motors under any one of the following conditions:

(a) Where a number of motors drive several parts of a single machine or piece of apparatus such as metal and woodworking machines, cranes, and hoists.

(b) Where a group of motors is under the protection of one set of overcurrent devices as permitted by E-430.053(1).

(c) Where a group of motors is in a single room within sight from the location of the disconnecting means.

(2) The disconnecting means shall have a rating not less than is required by E-430.109 for a single motor the rating of which equals the sum of the horsepowers or currents of all the motors of the group.

J. Requirements for Over 600 Volts

E-430.121. General.

The provisions of Part J recognize the additional hazard due to the use of high voltage. They are in addition to or amendatory of the other provisions of this chapter. Other requirements for circuits and equipment operating at more than 600 volts are in Chapter E-710.

E-430.122. More Than 7500 Volts.

Motors operating at more than 7500 volts between conductors shall be installed in fire-resistant motor rooms.

E-430.123. Motor Running Overcurrent (Overload) Protection.

Running overcurrent protection for a motor of over 600 volts shall consist either of a circuit-breaker, or of overcurrent units integral with the controller which shall simultaneously open all ungrounded conductors to the motor. The overcurrent device shall have a setting as specified elsewhere in this Chapter for motor-running overcurrent (overload) protection.

E-430.124. Short-Circuit and Ground Fault Protection.

Each motor branch circuit and feeder of more than 600 volts shall be protected against overcurrent by one of the following means:

(1) A circuit-breaker of suitable rating so arranged that it can be serviced without hazard.

(2) Fuses of the oil-filled or other suitable type. Fuses shall be used with suitable disconnecting means or they shall be of a type which can also serve as the

disconnecting means. They shall be so arranged that they cannot be re-fused or replaced while they are energized.

(3) Differential protection may be employed to protect an alternating-current motor, the motor control apparatus, and the branch-circuit conductors against over-current due to short circuits or grounds. When all these elements are included within the protected zone of a differential protective system, the ratings or settings specified in E-430.052 do not apply.

Note 1. A differential protective system is a combination of two or more sets of current transformers and a relay or relays energized from their interconnected secondaries. The primaries of the current transformers are connected on both sides of the equipment to be protected, both ends of the motor phase windings being brought out for this purpose. All of the apparatus and circuits included between the sets of current transformers primaries constitute the protected zone. The current transformer secondaries and the relay elements are so interconnected that the relay elements respond only to a predetermined difference between the currents entering and leaving the protected zone. When actuated, the relay or relays serve to trip the branch-circuit circuit breaker, thus disconnecting the motor, control apparatus in the motor circuit and the branch-circuit conductors from the source of power and, in the case of a synchronous motor, de-energizing its field circuit.

E-430.126. Disconnecting Means.

The circuit-breaker or the fuses specified in E-430.124 may constitute the disconnecting means if they conform to the other applicable requirements of this Chapter.

K. Protection of Live Parts - All Voltages

E-430.131. General.

The provisions of Part K specify that live parts shall be protected in a manner judged adequate to the hazard involved.

E-430.132. Where Required.

Exposed live parts of motors and controllers operating at 50 volts or more between terminals, shall be guarded against accidental contact by enclosure, or by location as follows:

(1) By installation in a room or enclosure which is accessible only to qualified persons;

(2) By installation on a suitable balcony, gallery or platform, so elevated and arranged as to exclude unqualified persons;

(3) By elevation 8 feet or more above the floor;

(4) So that it will be protected by a guard rail when the motor operates at 600 volts or less.

Exception: Stationary motors having commutators, collectors and brush rigging located inside of motor end brackets and not conductively connected to supply circuits operating at more than 150 volts to ground.

E-430.133. Guards for Attendants.

Where the live parts of motors or controllers operating at more than 150 volts to ground are guarded against accidental contact only by location as specified in E-430.132, and where adjustment or other attendance may be necessary during the operation of the apparatus, suitable insulating mats or platforms shall be provided so that the attendant cannot readily touch live parts unless standing on the mats or platforms. Where necessary, steps and hand-rails should be installed on or about large machines to afford safe access to parts which must be examined or adjusted during operation.

L. Grounding

E-430.141. General.

The provisions of Part L specify the grounding of motor and controller frames to prevent a potential above ground in the event of accidental contact between live parts and frames. Insulation, isolation, or guarding are suitable alternatives to

grounding of motors under certain conditions.

E-430.142. Stationary Motors.

(1) The frames of stationary motors shall be grounded where any of the following conditions exist:

(a) supplied by means of metal-clad wiring.

(b) located in a wet place and not isolated nor guarded.

(c) in a hazardous location. (See Chapters E-500 to E-517 inclusive.)

(d) the motor operates with any terminal at more than 150 volts to ground.

(2) Grounding of the motor frame is preferable, but where the frame of the motor is not grounded, it shall be permanently and effectively insulated from the ground.

E-430.143. Portable Motors.

The frames of portable motors which operate at more than 150 volts to ground shall be guarded or grounded. See E-250.045(4) on grounding of portable appliances in other than residential occupancies.

Note 1. It is recommended that the frames of motors which operate at less than 150 volts to ground be grounded where this can be readily accomplished.

Note 2. See E-250.059(2) for color of grounding conductor.

E-430.144. Controllers.

Controller cases, except those attached to ungrounded portable equipment and except the lined covers of snap switches, shall be grounded regardless of voltage.

E-430.145. Method of Grounding.

Grounding where required shall be done in the manner specified in Chapter E-250.

(1) Grounding Through Terminal Housings. Where the wiring to fixed motors is in armored cable or metal raceways, junction boxes to house motor terminals shall be provided, and the armor of the cable or the metal raceways shall be con-

nected to them in the manner specified in Chapter E-250.

(2) Separation of Junction Box from Motor. The junction box required by E-430.145(1) may be separated from the motor not more than 6 feet provided the leads to the motor are armored cable or armored cord or are stranded leads enclosed in flexible or rigid conduit or electrical metallic tubing not smaller than 3/8 inch electrical trade size, the armor or raceway being connected both to the motor and to the box. Where stranded leads are used, protected as specified above, they shall not be larger than No. 10, and shall comply with other requirements of the code for conductors to be used in raceways.

Table E-430.146. Overcurrent Protection for Motors
(See Tables E-430.152 and E-430.153)

These values are in accordance with E-430.006, E-430.022, E-430.032, E-430.034, E-430.052, E-430.059, except as follows: The current values in Column 1 are to be taken from Tables E-430.147 through E-430.150, including footnotes, but the values shown for running protection in Columns 2 and 3 must be modified if nameplate full load current values are different, as provided in E-430.006. The current values shown in Columns 2 and 3 must be reduced by 8 per cent for all motors other than open type motors marked to have a temperature rise of not over 40°C. as required by E-430.032. For certain exceptions to the values in Columns 4, 5, 6, and 7, see E-430.052 and E-430.059. See E-430.053 for values to be used for several motors on one branch circuit. For running protection of motors, see E-430.032. For setting of motor-branch-circuit protective devices, see Tables in E-430.152 and E-430.153. For grouping of small motors under the protection of a single set of fuses, see E-430.053.

Col. No. 1	2	3	4	5	6	7
			Maximum Allowable Rating or Setting of Branch Circuit Protective Devices			
Full load current rating of motor amperes	For Running Protection of Motors		With Code Letters Single phase, squirrel cage and synchronous. Full voltage, resistor or reactor starting, Code letters F to V inclusive. Without Code Letters Same as above.	With Code Letters Single phase, squirrel cage and synchronous Full voltage, resistor or reactor start, Code letters B to E inclusive. Auto transformer start, Code letters F to V inclusive. Without Code Letters (Not more than 30 Amperes) squirrel cage and synchronous, auto transformer start, high reactance squirrel cage.*	With Code Letters Squirrel cage and synchronous auto transformer start, Code letters B to E inclusive. Without Code Letters (More than 30 amperes) squirrel cage and synchronous auto transformer start, high reactance squirrel cage.*	With Code Letters All motors code letter A. Without Code Letters DC and wound rotor motors.
	Maximum rating of nonadjustable protective devices.	Maximum setting of adjustable protective devices.				

Table E-430.146. continued.

Col. No. 1	2	3	4		5		6		7	
	Amperes	Amperes	Fuses	Circuit Breakers (Non-adjustable Overload Trip)	Fuses	Circuit Breakers (Non-adjustable Overload Trip)	Fuses	Circuit Breakers (Non-adjustable Overload Trip)	Fuses	Circuit Breakers (Non-adjustable Overload Trip)
1	2	1.25	15	15	15	15	15	15	15	15
2	3	2.50	15	15	15	15	15	15	15	15
3	4	3.75	15	15	15	15	15	15	15	15
4	6	5.0	15	15	15	15	15	15	15	15
5	8	6.25	15	15	15	15	15	15	15	15
6	8	7.50	20	15	15	15	15	15	15	15
7	10	8.75	25	20	20	15	15	15	15	15
8	10	10.0	25	20	20	20	20	20	15	15
9	12	11.25	30	30	25	20	20	20	15	15
10	15	12.50	30	30	25	20	20	20	15	15
11	15	13.75	35	30	30	30	25	30	20	20
12	15	15.00	40	30	30	30	25	30	20	20
13	20	16.25	40	40	35	30	30	30	20	20
14	20	17.50	45	40	35	30	30	30	25	30
15	20	18.75	45	40	40	30	30	30	25	30
16	20	20.00	50	40	40	40	35	40	25	30
17	25	21.25	60	50	45	40	35	40	30	30
18	25	22.50	60	50	45	40	40	40	30	30
19	25	23.75	60	50	50	40	40	40	30	30
20	25	25.00	60	50	50	40	40	40	30	30
22	30	27.50	70	70	60	50	45	50	35	40
24	30	30.00	80	70	60	50	50	50	40	40
26	35	32.50	80	70	70	70	60	70	40	40
28	35	35.00	90	70	70	70	60	70	45	50

*See note at end of table.

continued next page.

Table E-430.146 continued.

Col. No. 1	2	3	4		5		6		7	
30	40	37.50	90	100	80	70	60	70	45	50
32	40	40.00	100	100	80	70	70	70	50	50
34	45	42.50	110	100	90	70	70	70	60	70
36	45	45.00	110	100	90	100	80	100	60	70
38	50	47.50	125	100	100	100	80	100	60	70
40	50	50.00	125	100	100	100	80	100	60	70
42	50	52.50	125	125	110	100	90	100	70	70
44	60	55.00	125	125	110	100	90	100	70	70
46	60	57.50	150	125	125	100	100	100	70	70
48	60	60.00	150	125	125	100	100	100	80	100
50	60	62.50	150	125	125	100	100	100	80	100
52	70	65.00	175	150	150	125	110	125	80	100
54	70	67.50	175	150	150	125	110	125	90	100
56	70	70.00	175	150	150	125	125	125	90	100
58	70	72.50	175	150	150	125	125	125	90	100
60	80	75.00	200	150	150	125	125	125	90	100
62	80	77.50	200	175	175	125	125	125	100	100
64	80	80.00	200	175	175	150	150	150	100	100
66	80	82.50	200	175	175	150	150	150	100	100
68	90	85.00	225	175	175	150	150	150	110	125
70	90	87.50	225	175	175	150	150	150	110	125
72	90	90.00	225	200	200	150	150	150	110	125
74	90	92.50	225	200	200	150	150	150	125	125
76	100	95.00	250	200	200	175	175	175	125	125
78	100	97.50	250	200	200	175	175	175	125	125
80	100	100.00	250	200	200	175	175	175	125	125
82	110	102.50	250	225	225	175	175	175	125	125
84	110	105.00	250	225	225	175	175	175	150	150
86	110	107.50	300	225	225	175	175	175	150	150
88	110	110.00	300	225	225	200	200	200	150	150
90	110	112.50	300	225	225	200	200	200	150	150
92	125	115.00	300	250	250	200	200	200	150	150
94	125	117.50	300	250	250	200	200	200	150	150
96	125	120.00	300	250	250	200	200	200	150	150
98	125	122.50	300	250	250	200	200	200	150	150
100	125	125.00	300	250	250	200	200	200	150	150

Continued next page.

Table E-430.146 continued.

Col. No. 1	2	3	4		5		6		7	
105	150	131.50	350	300	300	225	225	225	175	175
110	150	137.50	350	300	300	225	225	225	175	175
115	150	144.00	350	300	300	250	250	250	175	175
120	150	150.00	400	300	300	250	250	250	200	200
125	175	156.50	400	350	350	250	250	250	200	200
130	175	162.50	400	350	350	300	300	300	200	200
135	175	169.00	450	350	350	300	300	300	225	225
140	175	175.00	450	350	350	300	300	300	225	225
145	200	181.50	450	400	400	300	300	300	225	225
150	200	187.50	450	400	400	300	300	300	225	225
155	200	194.00	500	400	400	350	350	350	250	250
160	200	200.00	500	400	400	350	350	350	250	250
165	225	206.00	500	500	450	350	350	350	250	250
170	225	213.00	500	500	450	350	350	350	300	300
175	225	219.00	600	500	450	350	350	350	300	300
180	225	225.00	600	500	450	400	400	400	300	300
185	250	231.00	600	500	500	400	400	400	300	300
190	250	238.00	600	500	500	400	400	400	300	300
195	250	244.00	600	500	500	400	400	400	300	300
200	250	250.00	600	500	500	400	400	400	300	300
210	250	263.00	800	600	600	500	450	500	350	350
220	300	275.00	800	600	600	500	450	500	350	350
230	300	288.00	800	600	600	500	500	500	350	350
240	300	300.00	800	600	600	500	500	500	400	400
250	300	313.00	800	700	800	500	500	500	400	400
260	350	325.00	800	700	800	600	600	600	400	400
270	350	338.00	1000	700	800	600	600	600	450	500
280	350	350.00	1000	700	800	600	600	600	450	500
290	350	363.00	1000	800	800	600	600	600	450	500
300	400	375.00	1000	800	800	600	600	600	450	500
320	400	400.00	1000	800	800	700	800	700	500	500
340	450	425.00	1200	...	1000	700	800	700	600	600
360	450	450.00	1200	...	1000	800	800	800	600	600
380	500	475.00	1200	...	1000	800	800	800	600	600
400	500	500.00	1200	...	1000	800	800	800	600	600
420	600	525.00	1600	...	1200	...	1000	...	800	700

Continued next page.

Table E-430.146 continued.

Colm. No. 1	2	3			5		6		7	
440	600	550.00	1600	...	1200	...	1000	...	800	700
460	600	575.00	1600	...	1200	...	1000	...	800	700
480	600	600.00	1600	...	1200	...	1000	...	800	800
500	...	625.00	1600	...	1600	...	1000	...	800	800

*High-reactance squirrel-cage motors are those designed to limit the starting current by means of deepslot secondaries or double-wound secondaries and are generally started on full voltage.

Table E-430.147. Full Load Currents in Amperes

Direct Current Motors

The following values of full-load currents are for motors running at base speed.

HP	120 V	240 V
¼	2.9	1.5
1/3	3.6	1.8
½	5.2	2.6
3/4	7.4	3.7
1	9.4	4.7
1½	13.2	6.6
2	17	8.5
3	25	12.2
5	40	20
7½	58	29
10	76	38
15		55
20		72
25		89
30		106
40		140
50		173
60		206
75		255
100		341
125		425
150		506
200		675

Table E-430.148. Full Load Currents in Amperes

Single Phase Alternating Current Motors

The following values of full-load currents are for motors running at usual speeds and motors with normal torque characteristics. Motors built for especially low speeds or high torques may have higher full-load currents, in which case the nameplate current ratings should be used.

To obtain full-load currents of 208 and 200-volt motors, increase corresponding 230-volt motor full-load currents by 10 and 15 per cent, respectively.

HP	115V	230V	440V
1/6	4.4	2.2	...
1/4	5.8	2.9	...
1/3	7.2	3.6	...
1/2	9.8	4.9	...
3/4	13.8	6.9	...
1	16	8	...
1½	20	10	...
2	24	12	...
3	34	17	...
5	56	28	...
7½	80	40	21
10	100	50	26

Table E-430.149. Full-Load Current

Two-Phase A. C. Motors (4-wire)

The following values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, in which case the nameplate current rating should be used. Current in common conductor of 2-phase, 3-wire system will be 1.41 times value given.

	Induction Type Squirrel-Cage and Wound Rotor Amperes					Synchronous Type *Unity Power Factor Amperes			
HP	110V	220V	440V	550V	2300V	220V	440V	5550V	2300V
1/2	4	2	1	.8					
3/4	4.8	2.4	1.2	1.0					
1	6.4	3.2	1.6	1.3					
1½	8.8	4.4	2.2	1.8					
2	11.2	5.6	2.8	2.2					
3		8	4	3.2					
5		13	7	6					
7½		19	9	8					
10		24	12	10					
15		34	17	14					
20		45	23	18					
25		55	28	22	6	47	24	19	4.7
30		67	34	27	7.5	56	29	23	5.7
40		88	44	35	9	75	37	31	7
50		108	54	43	11	94	47	38	9
60		129	65	52	13	111	56	44	11
75		158	79	63	16	140	70	57	13
100		212	106	85	21	182	93	74	17
125		268	134	108	26	228	114	93	22
150		311	155	124	31		137	110	26
200		415	208	166	41		182	145	35

*For 90 and 80 per cent P.F. the above figures should be multiplied by 1.1 and 1.25 respectively.

Table E-430.150. Full-Load Current*

Three-Phase A.C. Motors

	Induction Type Squirrel-Cage and Wound Rotor Amperes					Synchronous Type **Unity Power Factor Amperes			
HP	110V	220V	440V	550V	2300V	220V	440V	550V	2300V
1/2	4	2	1	.8					
3/4	5.6	2.8	1.4	1.1					
1	7	3.5	1.8	1.4					
1½	10	5	2.5	2.0					
2	13	6.5	3.3	2.6					
3		9	4.5	4					
5		15	7.5	6					
7½		22	11	9					
10		27	14	11					
15		40	20	16					
20		52	26	21					
25		64	32	26	7	54	27	22	5.4
30		78	39	31	8.5	65	33	26	6.5
40		104	52	41	10.5	86	43	35	8
50		125	63	50	13	108	54	44	10
60		150	75	60	16	128	64	51	12
75		185	93	74	19	161	81	65	15
100		246	123	98	25	211	106	85	20
125		310	155	124	31	264	132	106	25
150		360	180	144	37		158	127	30
200		480	240	192	48		210	168	40

For full-load currents of 208 and 200 volt motors, increase the corresponding 220-volt motor full-load current by 6 and 10 per cent, respectively.

*These values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, in which case the nameplate current rating should be used.

**For 90 and 80 per cent P.F. the above figures should be multiplied by 1.1 and 1.25 respectively.

Table E-430.151

Locked-Rotor Current Conversion Table

As Determined from Horsepower and Voltage Rating
For Use Only with E-430.083, Exception No. 3, and E-430.110(2)

Conversion Table

Max. HP Rating	Maximum Interrupting Capacity - Amperes					
	Single Phase		Two or Three Phase			
	115 V	230 V	110 V	220 V	440 V	550 V
1/2	58.8	29.4	24	12	6	4.8
3/4	82.8	41.4	33.6	16.8	8.4	6.6
1	96	48	42	21	10.8	8.4
1 1/2	120	60	60	30	15	12
2	144	72	78	39	19.8	15.6
3	204	102	---	54	27	24
5	336	168	--	90	45	36
7 1/2	480	240	--	132	66	54
10	600	300	--	162	84	66
15	--	--	--	240	120	96
20	--	--	--	312	156	126
25	--	--	--	384	192	156
30	--	--	--	468	234	186
40	--	---	--	624	312	246
50	--	--	--	750	378	300
60	--	--	--	900	450	360
75	--	--	--	1110	558	444
100	--	--	--	1476	738	588
125	--	--	--	1860	930	744
150	--	--	--	2160	1080	864
200	--	--	--	2880	1440	1152

Table E-430.152

Maximum Rating or Setting of Motor-Branch-Circuit Protective Devices for Motors Marked with a Code Letter Indicating Locked Rotor KVA

Type of Motor	Per Cent of Full-Load Current		
	Fuse Rating See also Table E-430.146, Columns 4, 5, 6, 7	Circuit Breaker Setting: Instantaneous Type	Circuit Breaker Setting: Time Limit Type
All AC single-phase and polyphase squirrel cage and synchronous motors with full-voltage, resistor or reactor starting:			
Code Letter A	150	. . . .	150
Code Letter B to E .	250	. . . .	200
Code Letter F to V .	300	. . . .	250
All AC squirrel cage and synchronous motors with auto-transformer starting:			
Code Letter A	150	. . . .	150
Code Letter B to E .	200	. . . .	200
Code Letter F to V .	250	. . . .	200

Note 1. For certain exceptions to the values specified see E-430.052 and E-430.054. The values given in the last column also cover the ratings of non-adjustable, time-limit types of circuit-breakers which may also be modified as in E-430.052.

Note 2. Synchronous motors of the low-torque, low-speed type (usually 450 RPM or lower), such as are used to drive reciprocating compressors, pumps, etc., which start up unloaded, do not require a fuse rating or circuit-breaker setting in excess of 200 per cent of full-load current.

Note 3. For motors not marked with a Code Letter, see Table E-430.153.

Table E-430.153

Maximum Rating or Setting of Motor-Branch-Circuit Protective Devices for Motors not Marked with a Code Letter Indicating Locked Rotor KVA

Type of Motor	Per Cent of Full-Load Current		
	Fuse Rating See also Table E-430.146, Columns 4, 5, 6, 7	Circuit-Breaker Setting	
		Instantaneous Type	Time Limit Type
Single-phase, all types . .	300	. . .	250
Squirrel-cage and synchronous (full-voltage, resistor and reactor starting)	300	. . .	250
Squirrel-cage and synchronous (auto-transformer starting)			
Not more than 30 amperes	250	. . .	200
More than 30 amperes . .	200	. . .	200
High-reactance squirrel-cage			
Not more than 30 amperes .	250	. . .	250
More than 30 amperes . . .	200	. . .	200
Wound-rotor	150	. . .	150
Direct-current			
Not more than 50 H.P. . .	150	250	150
More than 50 H.P.	150	175	150

Note 1. For certain exceptions to the values specified see E-430.052, and E-430.059. The values given in the last column also cover the ratings of non-adjustable, time-limit types of circuit-breakers which may also be modified as in E-430.052.

Note 2. Synchronous motors of the low-torque, low speed type (usually 450 RPM or lower) such as are used to drive reciprocating compressors, pumps, etc., which start up unloaded, do not require a fuse rating or circuit-breaker setting in excess of 200 per cent of full-load current.

Note 3. For motors marked with a Code Letter, see Table E-430.152.

CHAPTER E-445

GENERATORS

E-445.01. Location.

Generators shall be located in dry places, and also so as to meet the requirements for motors in E-430.014. Generators installed in hazardous locations as described in Chapters E-500 - E-503, or in other locations as described in Chapters E-510 - E-517, E-520, E-530, and E-665, shall also comply with the provisions of those Chapters.

Note: It is recommended that waterproof covers be provided for use in emergency.

E-445.02. Marking.

Each generator shall be provided with a nameplate giving the maker's name, the rating in kilowatts or kilovolt-amperes, the normal volts and amperes corresponding to the rating, and the revolutions per minute.

E-445.03. Drip Pans.

Generators shall be provided with suitable drip pans if required by the administrative authority.

E-445.04. Overcurrent Protection.

(1) Constant-Potential Generators. Constant-potential generators, except alternating-current generators and their exciters, shall be protected from excessive current by circuit-breakers or fuses.

(2) Two-Wire Generators. Two-wire, direct-current generators may have overcurrent protection in one conductor only if the overcurrent device is actuated by the entire current generated, exc ept that in the shunt field. The overcurrent device shall not open the shunt field.

(3) 65 Volts or Less. Generators operating at 65 volts or less and driven by individual motors shall be considered as protected by the overcurrent device protecting the motor if these devices will operate when the generators are delivering

not more than 150 per cent of their full-load rated current.

(4) Balancer Sets. Two-wire, direct-current generators used in conjunction with balancer sets to obtain neutrals for 3-wire systems shall be equipped with overcurrent devices which will disconnect the 3-wire system in the case of excessive unbalancing of voltages or currents.

(5) 3-Wire, Direct-Current Generators. Three-wire, direct-current generators, whether compound or shunt wound, shall be equipped with overcurrent devices, one in each armature lead, and so connected as to be actuated by the entire current from the armature. Such overcurrent devices shall consist either of a double-pole, double-coil circuit-breaker, or of a 4-pole circuit-breaker connected in the main and equalizer leads and tripped by two overcurrent devices, one in each armature lead. Such protective devices shall be so interlocked that no one pole can be opened without simultaneously disconnecting both leads of the armature from the system.

E-445.05. Size of Conductors.

The conductors from the generator terminals to supplied equipment shall have a carrying capacity not less than 115 per cent of the nameplate current rating of the generator. Neutral conductors shall be the same size as the conductors of the outside legs.

E-445.06. Protection of Live Parts.

Live parts of generators of more than 150 volts to ground shall not be exposed to accidental contact where accessible to unqualified persons.

E-445.07. Guards for attendants.

Where necessary for the safety of attendants the provisions of E-430.133 shall be complied with.

E-445.08. Grounding.

If a generator operates at a terminal voltage in excess of 150 volts to ground, the frame shall be grounded in the manner specified in Chapter E-250. If the frame

is not grounded, it shall be permanently and effectively insulated from the ground.

E-445.09. Bushings.

Soft-rubber bushings used to protect lead wires where they pass through the frame of generators, shall not be exposed to oils, grease, oily vapors, or other substances having a deleterious effect on rubber.

CHAPTER E-450

TRANSFORMERS AND TRANSFORMER VAULTS
(Including Secondary Ties)

E-450.01. Application.

(1) This Chapter applies to the installation of all transformers except: (1) current transformers; (2) dry-type transformers which constitute a component part of other apparatus and which conform to the requirements for such apparatus; (3) transformers for use with X-ray and high-frequency; (4) transformers used with Class 1 low-voltage power circuits or Class 2 remote control low-energy power and signal circuits which shall conform to Chapter E-725; (5) transformers for sign and outline lighting which shall conform to Chapter E-600; and (6) transformers for electric discharge lighting which shall conform to Chapter E-410.

(2) This Chapter applies to the installation of transformers in hazardous locations except as modified by Chapter E-500.

Note: Supplementary rules are found also in Chapter E-710, Circuits and Equipment Operating at More than 600 Volts Between Conductors; and Service Installations Over 600 Volts as referred to in Chapter E-230.

A. General Provisions

E-450.02. Location.

Transformers and transformer vaults shall be readily accessible to qualified personnel for inspection and maintenance. The location of oil insulated transformers and transformer vaults is covered in E-450.24, E-450.25, and E-450.41; dry type transformers in E-450.21 and askarel insulated in E-450.23.

E-450.03. Overcurrent Protection.

(1) Overcurrent protection shall conform to the following. As used in this Chapter, the word "transformer" means a transformer or a bank of transformers operating as a unit.

(a) Primary Side. Each transformer shall be protected by an individual overcurrent device in the primary connection, rated or set at not more than 250

per cent of the rated primary current of the transformer, except that an individual overcurrent device is not required when the primary circuit overcurrent device provides the protection specified in this paragraph, and except as provided in E-450.03(b).

(b) Primary and Secondary Side. A transformer having an overcurrent device in the secondary connection, rated or set at not more than 250 per cent of the rated secondary current of the transformer, or a transformer equipped with a coordinated thermal overload protection by the manufacturer, is not required to have an individual overcurrent device in the primary connection provided the primary feeder overcurrent device is rated or set to open at a current value not more than six times the rated current of the transformer for transformers having not more than six per cent impedance, and not more than four times rated current of the transformer for transformers having more than six but not more than ten per cent impedance.

(c) Potential (Voltage) Transformers. Potential transformers should be protected with primary fuses. The fuse rating should not exceed 10 amperes for circuits of 600 volts or less, and 3 amperes for circuits of more than 600 volts. A resistor should be connected in series with high tension fuses when necessary to limit the possible short-circuit current to a value within the interrupting capacity of the fuse.

E-450.05. Secondary Ties.

(1) As used in this Chapter, the word "transformer" means a transformer or a bank of transformers operating as a unit. A secondary tie is a circuit operating at 600 volts or less between phases which connects two power sources or power supply points, such as the secondaries of two transformers. The tie may consist of one or more conductors per phase.

(a) Tie Circuits. Tie circuits shall be provided at each end with overcurrent protection as required in Chapter E-240 of this Code, except under the conditions described in E-450.05(1)(a)1. and E-450.05(1)(a)2., in which cases the overcurrent protection may be in accordance with E-450.05 (1)(a)3.

1. Loads at Transformer Supply Points Only. Where all loads are connected at the transformer supply points at each end of the tie and overcurrent protection is not provided in accordance with Chapter E-240, the rated current-carrying capacity of the tie shall be not less than 67 per cent of the rated secondary current of the largest transformer connected to the secondary tie system.

2. Loads Connected Between Transformer Supply Points. Where load is connected to the tie at any point between transformer supply points and overcurrent protection /is not provided in accordance with Chapter E-240, the rated current-carrying capacity of the tie shall be not less than 100 per cent of the rated secondary current of the largest transformer connected to the secondary tie system except as otherwise provided in E-450.05/(1)(a)2. and E-450.05 (1)(a)4..

3. Tie Circuit Protection. Under the conditions described in E-450.05/(1)(a)1. and E-450.05/(1)(a)2., both ends of each tie conductor shall be equipped with a protective device which will open at a predetermined temperature of the tie conductor under short circuit conditions. This protection shall consist of one of the following: (1) a fusible link cable connector, terminal or lug, commonly known as a limiter, each being of a size corresponding with that of the conductor and of approved construction and characteristics according to the operating voltage and the type of insulation on the tie conductors, or (2) automatic circuit-breakers actuated by devices having comparable current-time characteristics.

4. Interconnection of Phase Conductors Between Transformer Supply Points. Where the tie consists of more than one conductor per phase, the conductors of each phase shall be interconnected in order to establish a load supply point, and the protection specified in E-450.05/(1)(a)3. shall be provided in each tie conductor at this point, except as follows:

Exception: Loads may be connected to the individual conductors of a multiple-conductor tie without interconnecting the conductors of each phase and without the protection specified in E-450.05/(1)(a)3. at load connection points provided; the tie

conductors of each phase have a combined capacity not less than 133 per cent of the rated secondary current of the largest transformer connected to the secondary tie system; the total load of such taps does not exceed the rated secondary current of the largest transformer; the loads are equally divided on each phase and on the individual conductors of each phase as far as practicable.

5. Tie Circuit Control. Where the operating voltage exceeds 150 volts to ground, secondary ties provided with limiters shall have a switch at each end which when open will de-energize the associated tie conductors and limiters. The current rating of the switch shall be not less than the rated current of the conductors connected to the switch. It shall be capable of opening its rated current, and it shall be constructed so that it will not open under the magnetic forces resulting from short-circuit current.

(b) Overcurrent Protection for Secondary Connections. When secondary ties are used an overcurrent device rated or set at not more than 250 per cent of the rated secondary current of the transformers shall be provided in the secondary connections of each transformer, and in addition an automatic circuit-breaker actuated by a reverse-current relay set to open the circuit at not more than the rated secondary current of the transformer shall be provided in the secondary connection of each transformer.

E-450.06. Parallel Operation.

Transformers may be operated in parallel and protected as a unit when their electrical characteristics are such that they will divide the load in proportion to their rating.

E-450.07. Guarding.

Transformers shall be guarded as follows:

(1) Mechanical Protection. Appropriate provisions shall be made to minimize the possibility of damage to transformers from external causes where the transformers are located where they are exposed to physical damage.

(2) Case or Enclosure. Dry-type transformers shall be provided with a non-combustible moisture-resistant case or enclosure which will provide reasonable protection against the accidental insertion of foreign objects.

(3) Exposed Live Parts. The transformer installation shall conform with the provisions for guarding of live parts in E-195.16.

(4) Voltage Warning. The operating voltage of exposed live parts of transformer installations shall be indicated by signs or visible markings on the equipment or structures.

E-450.08. Grounding.

Exposed non-current carrying metal parts of transformer installations including fences, guards, etc. shall be grounded where required under the conditions and in the manner prescribed for electrical equipment and other exposed metal parts in Chapter E-250.

E-450.09. Marking.

Each transformer shall be provided with a nameplate giving the name of the manufacturer; rated kilovolt-amperes, frequency, primary and secondary voltage; and the amount and kind of insulating liquid where used and the transformer rating exceeds 25 kva. Where Class B insulation, as defined in American Standard for Transformers C 57.10 - 1953, is used in the construction of dry-type transformers of more than 100 kva, the nameplate shall so indicate.

B. Specific Provisions Applicable to Different Types of Transformers

E-450.21. Dry-Type Transformers Installed Indoors.

(1) Transformers rated 112½ kva or less shall have a separation of at least 12 inches from combustible material unless separated therefrom by a fire-resistant heat-insulating barrier, or unless of a rating not exceeding 600 volts and completely enclosed except for ventilating openings.

(2) Transformers of more than 112½ kva rating shall be installed in a transformer room of fire-resistant construction unless they are constructed with Class B

(80°C rise) or Class H (150°C rise) insulation, and are separated from combustible material not less than 6 feet horizontally and 12 feet vertically or are separated therefrom by a fire-resistant heat-insulating barrier.

(3) Transformers rated more than 15,000 volts shall be installed in a vault. See Part C of this Chapter.

E-450.23. Askarel-Insulated Transformers Installed Indoors.

Askarel-insulated transformers rated in excess of 25 kva shall be furnished with a pressure-relief vent. Where installed in a poorly ventilated place they shall be furnished with a means for absorbing any gases generated by arcing inside the case, or the pressure relief vent shall be connected to a chimney or flue which will carry such gases outside the building. Askarel-insulated transformers rated more than 15,000 volts shall be installed in a vault.

E-450.24. Oil-Insulated Transformers Installed Indoors.

Oil-insulated transformers shall be installed in a vault constructed as specified in this Chapter except as follows:

(1) Not Over 112½ kva Total Capacity. The provisions for transformer vaults specified in Part C of this Chapter apply except that the vault may be constructed of reinforced concrete not less than 4 inches thick.

(2) Not Over 600 Volts. A vault is not required provided suitable arrangements are made where necessary to prevent a transformer oil fire igniting other materials, and the total transformer capacity in one location does not exceed 10 kva in a section of the building classified as combustible, or 75 kva where the surrounding structure is classified as fire-resistant construction.

(3) Furnace Transformers. Electric furnace transformers of a total rating not exceeding 75 kva may be installed without a vault in a building or room of fire-resistant construction provided suitable arrangements are made to prevent a transformer oil fire spreading to other combustible material.

(4) Detached Buildings. Transformers may be installed in a building which

does not conform with the provisions specified in this Code for transformer vaults, provided neither the building nor its contents present a fire hazard to any other building or property, and provided the building is used only in supplying electric service and the interior is accessible only to qualified persons.

E-450.25. Oil-Insulated Transformers Installed Outdoors.

Combustible material, combustible buildings and parts of buildings, fire escapes, door and window openings shall be safeguarded from fires originating in oil-insulated transformers installed on, attached to, or adjacent to a building or combustible material. Space separations, fire-resistant barriers and enclosures which confine the oil of a ruptured transformer tank are recognized safeguards. One or more of these safeguards shall be applied according to the degree of hazard involved in cases where the transformer installation presents a fire hazard. Oil enclosures may consist of fire-resistant dikes, curbed areas or basins, or trenches filled with coarse crushed stone. Oil enclosures shall be provided with trapped drains in cases where the exposure and the quantity of oil involved are such that removal of oil is important.

C. Provisions for Transformer Vaults

E-450.41. Location.

Vaults shall be located where they can be ventilated to the outside air without using flues or ducts wherever such an arrangement is practicable.

E-450.42. Construction.

The construction of the vault shall be such as to have adequate structural strength for the conditions and a minimum fire-resistance of two and one-half hours according to ASTM Fire Test Standard E119 - 41. The quality of the material used shall be of a grade approved by the administrative authority.

(1) As an example - The required fire-resistance may be obtained with roofs and walls of reinforced concrete not less than 6 inches thick, masonry of brick not less than 8 inches thick, of 12-inch load-bearing hollow tile or 12-inch load-bearing hollow concrete building units. The inside wall and roof surface of vaults

constructed of hollow tile and hollow concrete building units shall have a coating of cement or gypsum plaster not less than 3/4 inches thick. The vault shall have a concrete floor not less than 4 inches thick. Building walls and floors which meet these requirements may serve for the floor, roof, and one or more walls of the vault.

E-450.43. Doorways.

Any doorway leading from the vault into the building shall be protected as follows:

(1) Type of Door. Each doorway shall be provided with a tight-fitting door of a type approved for openings in Class A situations as defined in the NFPA Standard for Protection of Openings in Walls and Partitions Against Fire, No. 80 (National Fire Codes, Vol. III). The administrative authority may require such a door on each side of the wall where conditions warrant.

(2) Sills. A door sill or curb of sufficient height to confine within the vault the oil from the largest transformer shall be provided and in no case shall the height be less than 4 inches.

(3) Locks. Entrance doors shall be equipped with locks, and doors shall be kept locked, access being allowed only to qualified persons. Locks and latches shall be so arranged that the door may be readily and quickly opened from the inside.

E-450.44. Ventilation.

The ventilation shall be adequate to prevent a transformer temperature in excess of the values prescribed in American Standard for Transformers, C 57.10 - 1953.

E-450.45. Ventilation Openings.

When required by E-450.44, openings for ventilation shall be provided in accordance with the following:

(1) Location. Ventilation openings shall be located as far away as possible

from doors, windows, fire escapes, and combustible material.

(2) Arrangement. Vaults ventilated by natural circulation of air may have roughly half of the total area of openings required for ventilation in one or more openings near the floor and the remainder in one or more openings in the roof or in the sidewalls near the roof; or all of the area required for ventilation may be provided in one or more openings in or near the roof.

(3) Size. In the case of vaults ventilated to an outdoor area without using ducts or flues the combined net area of all ventilating openings after deducting the area occupied by screens, gratings, or louvers, shall be not less than 3 square inches per kva of transformer capacity in service, except that the net area shall be not less than 1 square foot for any capacity under 50 kva.

(4) Covering. Ventilation openings shall be covered with durable gratings, screens, or louvers, according to the treatment required in order to avoid unsafe conditions.

(5) Dampers. Where automatic dampers are used in the ventilation openings of vaults containing oil-insulated transformers, the actuating device should be made to function at a temperature resulting from fire and not at a temperature which might prevail as a result of an overheated transformer or bank of transformers. Automatic dampers should be so designed and constructed to minimize the possibility of accidental closing.

(6) Ducts. Ventilating ducts shall be constructed of fire-resistant material.

E-450.46. Drainage.

Where practicable, vaults containing more than 100 kva transformer capacity shall be provided with a drain or other means which will carry off any accumulation of oil or water in the vault unless local conditions make this impracticable. The floor shall be pitched to the drain when provided.

E-450.47. Water Pipes and Accessories.

Any pipe or duct systems foreign to the electrical installation should not

enter or pass through a transformer vault. Where the presence of such foreign systems cannot be avoided, appurtenances thereto which require maintenance at regular intervals shall not be located inside the vault. Arrangements shall be made where necessary to avoid possible trouble from condensation, leaks and breaks in such foreign systems. Piping or other facilities provided for fire protection or for water-cooled transformers are not deemed to be foreign to the electrical installation.

E-450.48. Storage in Vaults.

Materials shall not be stored in transformer vaults.

CHAPTER E-460

CAPACITORS

E-460.01. Application.

This Chapter applies to installation of capacitors on electric circuits in or on buildings.

Exception No. 1. Capacitors that are components of other apparatus shall conform to the requirements for such apparatus.

Exception No. 2. Capacitors in hazardous locations shall comply with additional requirements in Chapters E-500 - E-517.

E-460.02. Location.

An installation of capacitors in which any single unit contains more than three gallons of combustible liquid shall be in a vault conforming to Part C of Chapter E-450.

E-460.03. Mechanical Protection.

Capacitors shall be protected from physical damage by location or by suitable fences, barriers or other enclosures.

E-460.04. Cases and Supports.

Capacitors shall be provided with noncombustible cases and supports.

E-460.05. Transformers Used with Capacitors.

Transformers that are components of capacitor installations and are used for the purpose of connecting the capacitor to a power circuit shall be installed in accordance with Chapter E-450. The kva rating shall not be less than 135 per cent of the capacitor rating in kvar.

E-460.06. Drainage of Stored Charge.

Capacitors shall be provided with a means of draining the stored charge.

(1) Time of Discharge. The residual voltage of a capacitor shall be reduced to 50 volts or less within one minute after the capacitor is disconnected from the source of supply in the case of capacitors rated 600 volts or less and in five minutes in the case of capacitors rated more than 600 volts.

(2) Means of Discharge. The discharge circuit shall be either permanently connected to the terminals of the capacitor or capacitor bank, or provided with automatic means of connecting it to the terminals of the capacitor bank on removal of voltage from the line. Manual means of switching or connecting the discharge circuit shall not be used. The windings of motors, of transformers, or of other equipment directly connected to capacitors without a switch or overcurrent device interposed, constitutes a suitable discharge means.

E-460.07. Power Factor Correction - Motor Circuit.

The total kvar rating of capacitors which are connected on the load side of a motor controller shall not exceed the value required to raise the no-load power factor of the motor to unity.

E-460.08. Conductor Rating.

(1) The current-carrying capacity of capacitor circuit conductors shall be not less than 135 per cent of the rated current of the capacitor. The current-carrying capacity of conductors which connect a capacitor to the terminals of a motor or to motor circuit conductors, shall be not less than one-third the carrying capacity of the motor circuit conductors but not less than 135 per cent of the rated current of the capacitor.

(2) Overcurrent Protection.

(a) An overcurrent device shall be provided in each ungrounded conductor.

Exception: A separate overcurrent device is not required on the load-side of a motor running overcurrent device.

(b) The rating or setting of the overcurrent device shall be as low as practicable.

(3) Disconnecting Means.

(a) A disconnecting means shall be provided in each ungrounded conductor.

Exception: A separate disconnecting means is not required for a capacitor connected on the load side of a motor overcurrent device.

(b) The disconnecting device need not open all ungrounded conductors simultaneously.

(c) The disconnecting device may be used for disconnecting the capacitor from the line as a regular operating procedure.

(d) The continuous current carrying capacity of the disconnecting device shall be not less than 135 per cent of the rated current of the capacitor.

E-460.09. Rating or Setting of the Motor-Running Overcurrent Device.

Where a motor installation includes a capacitor connected on the load side of the motor-running overcurrent device, and the overcurrent device used can be adjusted, the rating or setting of the motor overcurrent device shall be determined as provided in ~~E-430.32~~ E-430.032, except that instead of using the full-load rated current of the motor as provided in that rule a lower value corresponding with the improved power-factor of the motor circuit shall be used. ~~E-430.22~~ E-430.022 applies with respect to the rating of the motor circuit conductors.

E-460.10. Grounding.

Capacitor cases shall be grounded in accordance with Chapter E-250.

E-460.11. Guarding.

All live parts of capacitors which are connected to circuits of more than 600 volts between conductors and are accessible to unqualified persons, shall be

enclosed or isolated. For isolation by elevation, see E-710.36.

E-460.12. Marking.

Each capacitor shall be provided with a nameplate giving the maker's name, rated voltage, frequency, kvar, or amperes, number of phases, and if filled with a combustible liquid, the amount of liquid in gallons. When filled with a non-flammable liquid, the nameplate shall so state. The nameplate shall also indicate if a capacitor has a discharge device inside the case.

CHAPTER E-470

RESISTORS AND REACTORS
(For Rheostats see E-430.82)

E-470.01. Location.

Resistors and reactors shall not be placed where exposed to physical damage. Where in the immediate vicinity of easily ignitible material they shall be of the oil-immersed type or shall be enclosed in metal boxes or cabinets. See Chapter E-500 for Hazardous Locations.

E-470.02. Space Separation.

Unless attached to a switchboard or other non-combustible material, or unless mounted as provided in E-470.03, resistors and reactors shall be separated from combustible material by a distance of not less than 1 foot.

E-470.03. On or In a Proximity to Combustible Material.

Where placed within a distance of 1 foot from combustible material, resistors and reactors shall be installed as follows:

(1) Slab or Panel. They shall be attached to a slab or panel of noncombustible, nonabsorptive material such as slate, soapstone, or marble.

(2) Size of Slab. The slab shall extend beyond the edges of the device and shall have a thickness proportioned to the size and weight of the device but shall not be less than $\frac{1}{2}$ inch thick.

(3) Supports. The slab shall be secured in position by supports independent

of those fastening the device to the slab. Bolts which support the device shall be countersunk at least 1/8 inch below the rear surface of the slab and shall be covered with insulating material.

E-470.04. Contacts.

Fixed and movable contacts shall be so designed that arcing will be kept at a minimum.

E-470.05. Reactor Materials.

Reactors shall be composed of noncombustible materials, and shall be mounted on noncombustible bases.

E-470.06. Mounting.

Enclosures when mounted on plain surfaces shall make contact with such surfaces only at the point of support, an air space of at least 1/4 inch being maintained between the enclosures and surfaces.

E-470.07. Conductor Insulation.

Insulated conductors used for connection between resistance elements and controllers shall be suitable for an operating temperature of not less than 90°C (194°F).

Exception: For motor starting service other conductor insulations may be used.

E-470.08. Incandescent Lamps as Resistors.

Incandescent lamps may be used as protective resistors for automatic controllers, or may by special permission be used as resistors in series with other devices and shall conform to the following:

(1) Mounting. They shall be mounted in porcelain receptacles on noncombustible supports.

(2) Voltage. They shall be so arranged that they cannot have impressed upon them a voltage greater than that for which they are rated.

(3) Nameplate. They shall be provided with a nameplate, permanently attached, giving the wattage and voltage of the lamp to be used in each receptacle.

(4) Not Carry Main Current. They shall not carry or control the main current nor constitute the regulating resistance of the device.

CHAPTER E-480

STORAGE BATTERIES

E-480.01. Scope.

The provisions of this Chapter shall apply to all stationary installations of storage batteries using acid or alkali as the electrolyte and consisting of a number of cells connected in series with a nominal voltage in excess of 16 volts.

E-480.02. Definition of Nominal Battery Voltage.

The nominal battery voltage shall be calculated on the basis of 2.0 volts per cell for the lead-acid type, and 1.2 volts per cell for the alkali type.

E-480.03. Wiring and Apparatus Supplied From Batteries.

Wiring, appliances, and apparatus supplied from storage batteries shall be subject to the requirements of this Code applying to wiring, appliances, and apparatus operating at the same voltage, except as otherwise provided for communication systems in Chapter E-800.

E-480.04. Insulation of Batteries of Not Over 250 Volts.

The provisions of this rule shall apply to storage batteries having the cells so connected as to operate at a nominal battery voltage not exceeding 250 volts.

(1) Lead-Acid Batteries. Cells in lead-lined wood tanks, where the number of cells in series does not exceed 25, shall be supported individually on glass or glazed porcelain insulators. Where the number of the cells in series exceeds 25, the cells shall be supported individually on oil insulators.

(2) Alkali-Type Batteries. Cells of the alkali type in jars made of conducting material shall be installed in trays of nonconducting material, with not over 20 cells in a series circuit in any one such tray, or the cells may be supported singly or in groups on porcelain or other suitable insulators.

(3) Unsealed Jars. Cells in unsealed jars made of nonconductive material shall be assembled in trays of glass or supported on glass or glazed porcelain insulators; or, where installed on a rack, shall be supported singly or in groups on

glass or other suitable insulators.

(4) Sealed Rubber Jars. Cells in sealed rubber or composition containers shall require no additional insulating support where the total nominal voltage of all cells in series does not exceed 150 volts. Where the total voltage exceeds 150 volts, batteries shall be sectionalized into groups of 150 volts or less and each group shall have the individual cells installed in trays or on racks. Where trays or racks are required for this type of cell, such trays or racks shall be supported on glass or glazed porcelain insulators or oil-type insulators.

(5) Sealed Glass or Plastic Jars. Cells in sealed glass jars or in sealed jars of approved heat resistant plastic, with or without wood trays, require no additional insulation.

E-480.05. Insulation of Batteries of Over 250 Volts.

The provisions of E-480.04 shall apply to storage batteries having the cells so connected as to operate at a nominal voltage exceeding 250 volts and, in addition, the provisions of this Chapter shall also apply to such batteries. Cells shall be installed in groups having a total nominal voltage of not over 250 volts, in trays or on racks supported on oil insulators.

Exception No. 1. Where each individual cell, or sub-group in the tray or rack, is supported on oil insulators, no additional insulation for the group need be provided.

Exception No. 2. Cells of not over 10 ampere-hour capacity in sealed glass jars may be grouped in trays, the total nominal voltage of all cells in such group not to exceed 250 volts, and each such tray to be supported on glass or glazed porcelain insulators, the trays being mounted on racks supported on oil insulators with a total nominal voltage of not over 500 volts for all cells in series on each such insulated rack.

Note: Maximum protection is secured by sectionalizing high-voltage batteries into cell groups insulated from each other.

E-480.06. Racks and Trays.

Racks and trays shall conform to the following:

(1) Racks. Racks, as required in this Chapter, refer to frames designed to support cells or trays. They shall be substantial, and made of:

(a) Wood, so treated as to be resistant to deteriorating action by the electrolyte; or

(b) Metal, so treated as to be resistant to deteriorating action by the electrolyte, and provided with nonconducting members directly supporting the cells or with suitable insulating material on conducting members; or

(c) Other similar suitable construction.

(2) Trays. Trays refer to frames such as crates or shallow boxes usually of wood or other nonconducting material, so constructed or treated as to be resistant to deteriorating action by the electrolyte.

E-480.07. Battery Rooms.

Battery rooms shall conform to the following:

(1) Use. Separate battery rooms or enclosures shall be required only for batteries in unsealed jars and tanks where the aggregate capacity at the 8-hour discharge rate exceeds 5 kilowatt hours.

(2) Ventilation. Provision shall be made for sufficient diffusion and ventilation of the gases from the battery to prevent the accumulation of an explosive mixture in the battery room.

(3) Wiring Method. In storage battery rooms, bare conductors, open wiring, Type MI cable or conductors in rigid conduit or electrical metallic tubing shall be used as the wiring method. Rigid metal conduit, or electrical metallic tubing, where used, shall be of corrosion-resistant material or shall be suitably protected from corrosion.

(4) Varnished-Cambric Conductors. Varnished-cambric-covered conductors, Type V, shall not be used.

(5) Bare Conductors. Bare conductors shall not be taped.

(6) Terminals. Where metal raceway or other metallic covering is used in the battery room, at least 12 inches of the conductor at the end connected to a cell terminal shall be free from the raceway or metallic covering and shall be bushed by a substantial glazed insulating bushing. The end of the raceway shall be sealed tightly to resist the entrance of electrolyte by spray or by creepage Sealing compound, rubber insulating tape or other suitable material shall be used for this purpose.

SPECIAL OCCUPANCIES

CHAPTER E-500

HAZARDOUS LOCATIONS

E-500.01. Scope.

(1) The provisions of Chapters E-500 - E-503 apply to locations in which the administrative authority judges the apparatus and wiring to be subject to the conditions indicated by the following classifications. It is intended that each room, section or area (including motor and generator rooms, and rooms for the enclosure of control equipment) shall be considered individually in determining its classification. Except as modified in Chapters E-500 - E-503, all other applicable rules contained in this Code shall apply to electrical apparatus and wiring installed in hazardous locations. For definitions of "approved" and "explosion-proof" as used in these Chapters, refer to Chapter E-100; "dust-ignition-proof" is defined in E-502.01.

(2) Equipment and associated wiring approved as intrinsically safe may be installed in any hazardous location for which it is approved, and the provisions of Chapters E-500 - E-517 need not apply to such installation. Intrinsically safe equipment and wiring is incapable of releasing sufficient electrical energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture. Abnormal conditions will include accidental damage to any part of the equipment or wiring,insulation or other failure of electrical components, application