

SPECIAL EQUIPMENT

CHAPTER E-600

ELECTRIC SIGNS AND OUTLINE LIGHTING

E-600.01. Scope.

A. General

The provisions of this Chapter shall apply to the installation of conductors and equipment for electric signs and outline lighting as defined in Chapter E-100.

E-600.02. Disconnect Required.

Each outline lighting installation, and each sign of other than the portable type, shall be controlled by an externally-operable switch or breaker which will open all ungrounded conductors and shall be suitable for conditions of installation, such as exposure to the weather.

(1) In Sight of Sign. The switch or breaker required by E-600.02 shall be within sight of the sign or outline lighting which it controls or may be located elsewhere when capable of being locked in the open position.

(2) Control Switch Rating. Switches, flashers, and similar devices controlling transformers shall be either of a type approved for the purpose, or have a current rating not less than twice the current rating of the transformers. On alternating-current circuits, general use alternating-current snap switches may be used to control inductive loads other than motors, not exceeding the ampere rating of switch. See E-380.14.

Note: The intent of this rule is to prohibit one sign enclosure being used as a pull box or raceway for conductors supplying other signs or equipment.

E-600.05. Grounding.

(1) Signs, troughs, tube terminal boxes and other metal frames shall be grounded in the manner specified in Chapter E-250 of this code, unless they are insulated from ground and from other conducting surfaces and are inaccessible to unauthorized persons.

(2) Isolated non-current-carrying metal parts of outline lighting may be bonded by No. 14 conductors and grounded in accordance with Chapter E-250.

(3) Signs of the portable incandescent or fluorescent-lamp type in which the open circuit voltage does not exceed 150 volts to ground are not required to be grounded.

E-600.06. Load of Branch Circuit.

Circuits shall be so arranged that the number of outlets, lamps, and transformers connected to them, shall in no case place more than 15 amperes on a branch-circuit.

E-600.07. Marking.

(1) Signs shall be marked with the maker's name, and for incandescent-lamp signs with the number of lampholders, and for electric discharge signs with input amperes at full load and input voltage. The marking of the sign shall be visible for inspection after installation.

(2) Transformers shall be marked with the maker's name, and transformers for electric discharge signs shall be marked with the input rating in amperes or volt-amperes, the input voltage and the open-circuit high-tension voltage.

E-600.08. Enclosures.

Enclosures for signs and outline lighting shall conform to the following:

(1) Conductors and Terminals. Conductors and terminals in sign boxes, cabinets, and outline troughs shall be enclosed, except the supply leads.

(2) Cutouts, Flashers, Etc. Cutouts, flashers, and similar devices shall be enclosed in metal boxes the doors of which shall be arranged so that they can be opened without removing obstructions or finished parts of the enclosure.

(3) Strength. Enclosures shall have ample strength and rigidity.

(4) Material. Except for portable signs of the indoor type, signs and outline lighting shall be constructed of metal or other noncombustible material. Wood may be used for external decoration if placed not less than 2 inches from the nearest lampholder or current-carrying part.

(5) Minimum Thickness - Enclosure Metal. Sheet copper shall be at least 20 ounce (0.028 / inch). Sheet steel may be of No. 28 MS (USS Revised) gauge except that for outline lighting and for electric discharge signs sheet steel shall be of No. 24 MS (USS Revised) gauge, unless ribbed, corrugated or embossed over its entire surface, when it may be of No. 26MS (USS Revised) gauge.

(6) Protection of Metal. All steel parts of enclosures shall be galvanized or otherwise protected from corrosion.

(7) Enclosures Exposed to the Weather. Enclosures for outside use shall be weatherproof and shall have an ample number of drain holes, each not larger than $\frac{1}{2}$ inch or smaller than $\frac{1}{4}$ inch. Wiring connections shall not be made through the bottoms of enclosures exposed to the weather unless the enclosures are of the raintight type.

E-600.09. Portable Gas Tube Signs.

All gas tube signs not coming within the definition of portable shall be wired in accordance with the code rule. Satisfactory portable signs may be installed by connection with portable cord.

Note: As applied to Neon or gas tube signs, portable means less than 75 pounds in weight and 10 square feet over the largest surface, with all high tension wires and tube terminals within the sign enclosure proper, and the tubes or lamps fastened only to and not extending beyond the sign surface or background. All portable gas tube signs shall have the metal enclosure grounded by a three-wire cord connected to a three-point receptacle and the portable cord shall be limited to six feet in length.

E-600.11. Tube Terminals.

The terminals shall be so designed that the tubing can be replaced without the necessity of exposing uninsulated live parts. If the spring contact type of receptacle is used, it shall be so designed that, even with the tube removed, the live spring will be recessed a distance equal to three times the diameter of the receptacle

opening. It is recommended that the primary circuit be controlled by a relay that will open the circuit when a tube in the secondary circuit is broken or removed. Live parts shall be protected by barriers which require other than ordinary tools such as pliers and screw-drivers for removal unless access to the parts requires the disconnection of the primary circuits. (See E-410.80).

B. Signs and Outline Lighting - 600 Volts or Less

E-600.21. Installation of Conductors.

Conductors shall be installed as follows:

(1) Wiring Method. Conductors shall be installed as open conductors on insulators, in rigid metal conduit, flexible metal conduit, electrical metallic tubing, armored cable, metal troughing or Type MI cable.

(2) Insulation and Size. Conductors shall be of a type approved for general use and, except in portable signs and for short leads permanently attached to lamp-holders or ballasts, shall be not smaller than No. 14.

(3) Exposed to the Weather. Conductors in raceways, armored cable or enclosures exposed to the weather, shall be of the lead-covered type or other type specially approved for the conditions, except where rigid conduit, electrical metallic tubing or enclosures are made raintight and arranged to drain.

(4) Number of Conductors in Raceway. Number of conductors in raceway for sign flashers may be in accordance with Table 1 of Chapter E-900.

(5) Open Conductors. Open conductors on insulators shall comply with the provisions of E-300.02 to E-300.22 inclusive, and, if outdoors, Chapter E-730, except that the separation between conductors need be only 2 inches.

Exception: Open conductors may be supported by lampholders located not more than 1 foot apart.

(6) Conductors Soldered to Terminals. Where the conductors are fastened to lampholders other than of the pin type, they shall be soldered to the terminals and

the exposed parts of conductors and terminals shall be treated to prevent corrosion. Where the conductors are fastened to pin-type lampholders which protect the terminals from the entrance of water, and which have been found acceptable for sign use, the conductors shall be of the stranded type but need not be soldered to the terminals.

E-600.22. Lampholders.

Lampholders shall be of the unswitched type having bodies of suitable insulating material and shall be so constructed and installed as to prevent turning. Miniature lampholders shall not be employed for outdoor signs and outline lighting.

C. Signs and Outline Lighting - Exceeding 600 Volts

E-600.31. Installation of Conductors.

Conductors shall be installed as follows:

(1) Wiring Method. Conductors shall be installed as open work, as concealed conductors on insulators, in rigid or flexible metal conduit, or in electrical metallic tubing.

(2) Insulation and Size. Conductors shall be of a type approved for the purpose and for the voltage of the circuit, and shall be not smaller than No. 14.

(3) Bends in Conductors. Sharp bends in the conductors shall be avoided.

(4) Open Conductors - Indoors. Open conductors indoors shall be mounted on noncombustible, nonabsorptive insulators. Insulators of porcelain shall be glazed on all exposed surfaces. A separation of at least $1\frac{1}{2}$ inches shall be maintained between conductors and between conductors and other objects. Conductors shall not be located where subject to physical damage.

(5) Concealed Conductors on Insulators - Indoors. Concealed conductors on insulators shall be separated from each other and from all objects other than the insulators on which they are mounted by a spacing of not less than $1\frac{1}{2}$ inches for voltages above 10,000 volts, and not less than 1 inch for voltages of 10,000 or less. They shall be installed in channels lined with noncombustible material and used for no other purpose, except that the primary circuit conductors may be in the same

channel. The insulators shall be of noncombustible, nonabsorptive material.

(6) Conductors in Raceways. Where the conductors are covered with lead or other metal sheathing, the covering shall extend beyond the end of the raceway, and the surface of the cable shall not be injured where the covering terminates.

(a) In damp or wet locations, the insulation on all conductors shall extend beyond the metal covering or raceway at least 4 inches for voltages over 10,000, 3 inches for voltages over 5,000 but not exceeding 10,000, and 2 inches for voltages of 5,000 or less.

(b) In dry locations the insulation shall extend beyond the end of the metal covering or raceways not less than $2\frac{1}{2}$ inches for voltages over 10,000, 2 inches for voltages over 5,000 but not exceeding 10,000, and $1\frac{1}{2}$ inches for voltages of 5,000 or less.

(c) For conductors at grounded midpoint terminals, no spacing is required.

(d) Not more than 20 feet of cable from a single transformer shall be run in metal raceway where the potential between the cable and the raceway is more than 5,000 volts.

(7) Open Conductors - Outdoors.

(a) Open conductors outdoors shall be mounted on noncombustible, non-absorptive insulators. Insulators of porcelain shall be glazed on all exposed surfaces. A separation of at least two inches shall be maintained between conductors, and between conductors and other objects.

(b) Where subject to physical damage, or where within reach from ground, roof, or window, conductors shall be enclosed in raceways or suitably guarded. Where guarded, a spacing of not less than $1\frac{1}{2}$ inches shall be maintained between conductors and the enclosure unless the enclosure is nonconducting and noncombustible.

(8) Show-Windows and Similar Locations. Conductors that hang freely in the air, away from combustible material, and where not subject to physical damage, as

in some show-window displays, need not be otherwise protected.

(9) Conductors may be run from the ends of tubing to the grounded midpoint of transformers specifically designed for the purpose and provided with terminals at the midpoint. Where such connections are made to the transformer grounded midpoint, the connections between the high-voltage terminals of the transformer and the line ends of the tubing shall be as short as possible.

E-600.32. Transformers.

Transformers shall comply with the following:

(1) Voltage. The transformer secondary open-circuit voltage shall not exceed 15,000 volts with an allowance on test of 1,000 volts additional. In end-grounded transformers the secondary, open-circuit voltage shall not exceed 7,500 volts with an allowance on test of 500 volts additional.

(2) Type.

(a) Transformers shall be of a type approved for the purpose and shall be limited in rating to a maximum of 4,500 volt-amperes.

(b) Open core-and-coil type transformers shall be limited to 5,000 volts with an allowance on test of 500 volts, and to indoor applications in small portable signs.

(c) Transformers for outline lighting installations shall have secondary current ratings not in excess of 30 milliamperes except where they and all wiring connected to them are installed in accordance with the provisions of Chapter E-410 for electric discharge lighting of the same voltage.

(3) Exposed to Weather. Transformers used outdoors shall be of the weather-proof type or shall be protected from the weather by enclosure in the sign body or in a separate metal box.

(4) Transformer Secondary Connections. The high-voltage windings of transformers shall not be connected in parallel; and shall not be connected in series, except that two transformers each having one end of its high-voltage winding connected to the metal enclosure may have their high-voltage windings connected in

series to form the equivalent of a midpoint grounded transformer. The grounded ends shall be connected by insulated conductors not smaller than No. 14.

(5) Accessibility. Transformers shall be accessible.

E-600.33. Electric Discharge Tubing.

Electric discharge tubing shall conform to the following:

(1) Design. The tubing shall be of such length and design as not to cause a continuous over-voltage on the transformer.

(2) Support. Tubing shall be adequately supported on noncombustible, non-absorptive supports. Tubing supports should, where practicable, be adjustable.

(3) Contact with Flammable Material and Other Surfaces. The tubing shall be free from contact with flammable material and shall be located where not normally exposed to physical damage. Where operating in excess of 7,500 volts, the tubing shall be supported on noncombustible, nonabsorptive, insulating supports which maintain a spacing of not less than $\frac{1}{4}$ inch between the tubing and the nearest surface.

E-600.34. Terminals and Electrode Receptacles for Electric Discharge Tubing.

Terminals and electrode receptacles for electric discharge tubing shall comply with the following:

(1) Terminals. Terminals of the tubing shall be inaccessible to unqualified persons and isolated from combustible material and grounded metal or shall be enclosed. Where enclosed they shall be separated from grounded metal and combustible material by noncombustible, nonabsorptive insulating material approved for the purpose or by $1\frac{1}{2}$ inches of air. Terminals shall be relieved from stress by the independent support of the tubing.

(2) Tube Connections Other Than With Receptacles. Where tubes do not terminate in receptacles designed for the purpose, all live parts of tube terminals and conductors shall be so supported as to maintain a separation of at least $1\frac{1}{2}$ inches between conductors or between conductors and any grounded metal.

(3) Receptacles. Electrode receptacles for the tubing shall be of noncombustible, nonabsorptive insulating material approved for the purpose.

(4) Bushings. Where electrodes enter the enclosure of outdoor signs or of an indoor sign operating at a voltage in excess of 7,500 volts, bushings shall be used unless receptacles are provided or the sign is wired with bare wire mounted on approved supports which maintain the tubing in proper position. Bushings shall be of noncombustible, nonabsorptive material. Where bare wiring is used, the conductor shall be not less than No. 14 solid copper, shall be supported so as to prevent sagging and lessening of the spacing required elsewhere in this Chapter, and electrode terminal assemblies shall be of an approved type and supported not more than 6 inches from the electrode terminals.

(5) Show-Windows. In the exposed type of show-window signs, terminals shall be (a) enclosed by receptacles approved for the purpose or (b) where hanging in air, free from grounded surfaces, enclosed in sleeves of vulcanized fiber, phenolic composition, or other suitable material which overlaps all live parts by at least $\frac{1}{2}$ inch.

(6) Receptacles and Bushing Seals. A flexible, non-conducting seal may be used to close the opening between the tubing and the receptacle or bushing against the entrance of dust or moisture. This seal shall not be in contact with grounded conductive material and shall not be depended upon for the insulation of the tubing.

(7) Enclosures of Metal. Enclosures of metal for electrodes shall be of not less than No. 24 MS (USS Revised) gauge sheet metal.

(8) Enclosures of Insulating Material. Enclosures of insulating material shall be noncombustible, nonabsorptive and approved for the voltage of the circuit.

E-600.35. Switches on Doors.

Doors or covers giving access to uninsulated parts of indoor signs or outline lighting exceeding 600 volts and accessible to the general public, shall either be provided with interlock switches which on the opening of the doors or covers disconnect the primary circuit, or shall be so fastened that the use of other than ordinary tools will be necessary to open them.

CHAPTER E-610
CRANES AND HOISTS

A. Scope and Use

E-610.01. Scope.

The provisions of this Chapter shall apply to the installation of cranes, crane runways, hoists and monorails.

Note: For definitions of various kinds of cranes and hoists see American Standard Safety Code for Cranes, Derricks and Hoists, ASA B30.2-1943.

E-610.02. Particular Locations.

(1) Ignitable Material Hazards. Installations in hazardous locations shall comply with the provisions of E-503.13.

(2) Combustible Materials. Where a crane operates over readily combustible material, the resistors shall be placed in a well-ventilated cabinet composed of non-combustible material so constructed that it will not emit flames or molten metal.

Exception: Resistors may be located in a cage or cab constructed of non-combustible material which encloses the sides of the cage/^{or cab}from the floor to a point at least 6 inches above the top of the resistors.

E-610.11. Wiring Method.

Conductors shall be enclosed in raceways or be Type MI cable.

Exception No. 1. Bare Conductors. Bare conductors used as contact conductors.

Exception No. 2. Open Conductors. Short lengths of open conductors at resistors, collectors, and other equipment.

Exception No. 3. Flexible Connections. Where flexible connections are necessary to motors and similar equipment, flexible metal conduit, armored cable, multiple conductor rubber-covered cable or an approved non-metallic enclosure may be employed.

Exception No. 4. Pendent Push-Button Stations. Where multiple conductor

cable is used with a suspended pushbutton station, the station must be supported in some satisfactory manner that will protect the electrical conductors against strain.

E-610.12. Raceway Terminal Fittings.

Conductors leaving raceways shall comply with the provisions of E-300.16.

E-610.13. Types of Conductors.

Conductors shall be of the rubber-covered or the thermoplastic type except:

Exception No. 1. Contact Conductors. Contact conductors along runways, crane bridges and monorails may be bare and may be of hard drawn copper, or aluminum, or steel in the form of tees, angles, tee rails, or other stiff shapes.

Exception No. 2. Flexible Conductors. Flexible conductors may be used to convey current and where practicable, cable reels or take-up devices may be employed.

Exception No. 3. Varnished Cambric Conductors. Varnished-cambric conductors (Type V) or asbestos varnished cambric (Types AVA and AVB) may be used in dry locations.

Exception No. 4. Type MI Cable. Type MI cable may be used in wet or dry locations within its specified temperature ratings.

Exception No. 5. Exposed to High Temperatures. Conductors exposed to external heat or connected to resistors shall have an insulation approved for the temperature and location as specified in E-310.02. Where conductors not having a flame-resistant outer covering are grouped together, the group shall be covered with a flame-resistant tape.

E-610.14. Conductors.

(1) Current-Carrying Capacity. The allowable current-carrying capacity of conductors shall be as shown in Table E-610.14(1). For the carrying capacity of conductors between controllers and resistors, see E-430.023.

(2) Minimum. Conductors shall not be smaller than No. 14.

Exception: No. 16 may be used for crane and hoist motor and control circuits only when the application meets E-610.14(1) current carrying capacity, and provided the conductors are protected against physical damage.

Table E-610.14(1)

Current-Carrying Capacity in Amperes of Insulated Conductors in Raceway or Cable
Used with Short Time Rated Crane and Hoist Motors

Max Operating Temp.	60°C		75°C		90°C		110°C	
	Type R, RW, T, TW		Type RH, RHW		Type TA, AVB, RHH, SA		Type AVA	
	60 min	30 min	60 min	30 min	60 min	30 min	60 min	30 min
16	10	10	10	12	..	..	..	..
14	20	20	25	26	31	32	38	40
12	25	25	30	33	36	40	45	50
10	35	35	40	43	49	52	60	65
8	45	50	55	60	63	69	73	80
6	57	70	76	86	83	94	93	105
5	65	80	85	95	95	106	109	121
4	77	95	100	117	111	130	126	147
3	90	115	120	141	131	153	145	168
2	107	130	137	160	148	173	163	190
1	130	150	143	175	158	192	177	215
0	160	180	190	233	211	259	239	294
00	195	225	222	267	245	294	275	331
000	245	280	280	341	305	372	339	413
0000	295	350	300	369	319	399	352	440
250	350	375	364	420	400	461	447	516
300	410	475	455	582	497	636	554	707
350	460	550	486	646	542	716	616	809
400	515	580	538	688	593	760	666	856
450	565	640	600	765	660	836	740	930
500	620	700	660	847	726	914	815	1004

Other insulations shown in E-310.02 and approved for the temperatures and location may be substituted for those shown in Table E-610.14(1). The allowable current-carrying capacity of conductors used with 15-minute motors shall be the 30-minute ratings increased by 12 per cent.

(3) Contact Conductors. The size of contact wires shall be not less than the following:

Distance between end strain insulators	Size of wire
0-30 feet	No. 6
31-60 feet	No. 4
over 60 feet	No. 2

E-610.15. Common Return.

Where a crane or hoist is operated by more than one motor, a common-return conductor of proper current-carrying capacity may be used.

C. Contact Conductors

E-610.21. Installation of Contact Conductors.

Bare contact conductors shall conform to the following:

(1) Contact Wires. Wires that are used as contact conductors shall be secured at the ends by means of approved strain insulators and shall be so mounted on approved insulators that the extreme limit of displacement of the wire will not bring the latter within less than $1\frac{1}{2}$ inches from the surface wired over.

(2) Supports Along Runways. Main contact conductors carried along runways shall be supported on insulating supports placed at intervals not exceeding 20 feet, and these supports shall be insulating except for grounded rail conductors as provided in E-610.21(5). Such conductors shall be separated not less than 6 inches except for monorail hoists where a spacing of not less than 3 inches may be used. Where necessary, intervals between insulating supports may be increased up to 40 feet, the separation between conductors being increased proportionately.

(3) Supports on Bridges. Bridge contact conductors shall be kept at least $2\frac{1}{2}$ inches apart and, where the span exceeds 80 feet, insulating saddles shall be placed at intervals not exceeding 50 feet.

Note: It is recommended that the distance between wires be greater than $2\frac{1}{2}$ inches where practicable.

(4) Supports for Rigid Conductors. Conductors along runways and crane bridges, which are of the rigid type specified in E-610.13, Exception No. 1, shall be carried on insulating supports spaced at intervals of not more than 80 times the vertical dimension of the conductor, but in no case greater than 15 feet, and spaced apart sufficiently to give a clear electrical separation of conductors or adjacent collectors of not less than 1 inch.

(5) Track as Circuit Conductor. Monorail, tramrail or crane-runway tracks may be used as a conductor of current for one phase of a three-phase alternating-current system furnishing power to the carrier, crane or trolley, provided all of the following conditions are fulfilled:

(a) The conductors for supplying the other two phases of the power supply shall be insulated.

(b) The power for all phases shall be obtained from an insulating transformer.

(c) The voltage shall not exceed 300 volts.

(d) The rail serving as a conductor shall be effectively grounded at the transformer and may also be grounded by the fittings used for the suspension or attachment of the rail to a building or structure.

(6) Electrical Continuity of Contact Conductors. All sections of bare rigid contact conductors shall be mechanically joined to provide a continuous electrical connection.

(7) Not to Supply Other Equipment. Contact conductors shall not be used as feeders for any equipment other than the crane or cranes which they are primarily designed to serve.

(8) Isolating or Guarding Contact Conductors. Except in locations to which only qualified persons are admitted, contact conductors shall be so isolated by elevation or be provided with suitable guards so arranged that persons cannot inadvertently touch the current-carrying parts while in contact with the ground or with conducting material connected to the ground.

E-610.22. Collectors.

Collectors shall be so designed as to reduce to a minimum sparking between them and the contact conductor, and when operated in rooms used for the storage of easily ignitable combustible fibers and materials the requirements of E-503.13 shall be complied with.

D. Control

E-610.31. Runway Conductor Disconnecting Means.

A disconnecting means shall be provided between the runway contact conductors and the power supply. Such disconnecting means shall consist of a motor-circuit switch or circuit-breaker, except that a general-use switch may be used when the disconnecting means is provided in accordance with E-610.32. This disconnecting means shall be readily accessible and operable from the ground, shall be arranged to be locked in the open position, shall open all ungrounded conductors simultaneously, and shall be placed within sight of the crane or hoist and the runway contact conductors.

E-610.32. Disconnecting Means for Crane.

Where a crane is operated from a cage or cab, a motor-circuit switch or circuit-breaker shall be provided in the leads from the runway contact conductors. The switch or circuit-breaker shall be in the cage or cab or mounted on the bridge and operable from the cage or cab when the trolley is at one end of the bridge.

E-610.33. Rating of Disconnecting Means for Crane.

On both alternating-current and direct-current crane protective panels, the continuous ampere rating of the switch or circuit-breaker required by E-610.32, and mainline contactors, shall be not less than 50 per cent of the combined short-time ampere ratings of the motors, nor less than 75 per cent of the sum of the short-time ampere ratings of the motors required for any single crane motion.

E-610.34. Limit Switch.

A limit switch shall be provided for upper limit of travel of crane hoists.

E. Overcurrent Protection

E-610.41. Contact Conductors.

The main contact conductors shall be protected by an overcurrent device.

E-610.42. Crane Motors.

Where more than one motor is employed on a crane, each motor shall have individual overcurrent protection as provided in Chapter E-430, except that where two motors operate a single hoist, carriage, truck, or bridge, and are controlled as a unit by one controller, the pair of motors with their leads may be protected by a single overcurrent device which shall be located in the cage or cab where there is one. Where the overcurrent device is not readily accessible, it shall be enclosed or guarded until it is electrically disconnected from the source of supply. See E-240.16 (1).

F. Grounding

E-610.51. Grounding.

Motor frames, tracks, the entire frame of a crane or hoist, and cases of controllers shall be grounded in the manner specified in Chapter E-250. Small portable hoists shall be grounded where required by E-250.045.

CHAPTER E-615

TROLLEY CONDUCTORS

E-615.01. Scope.

The provisions of this chapter shall apply to installations of trolley wires and feeders for supplying electric locomotives and cars.

E-615.02. Insulation of Trolley Wires.

Trolley wires shall have at least two separate and distinct insulations from the ground. A wooden pole or structure shall be considered as one insulation.

E-615.03. Control of Trolley Wires and Feeders.

Trolley wires and feeders shall be provided with a means by which they can be disconnected from their source of current.

CHAPTER E-620

ELEVATORS, DUMBWAITERS, AND ESCALATORS

A. Scope and General

E-620.001. Scope.

This chapter shall apply to electrical equipment and wiring used in connection with elevators, dumbwaiters, and escalators.

E-620.002. Voltage Limitations.

The nominal voltage used for elevator, dumbwaiter or escalator operating control and signal circuits, operating equipment, driving machine motors, machine brakes, and motor-generator sets shall not exceed the following:

(1) For operating control and signal circuits and related equipment including door operator motors: 300 volts except that higher potentials may be used for frequencies of 25 through 60 cycles alternating current or for direct current provided the current in the system cannot, under any conditions, exceed 8 milliamperes for alternating current or 30 milliamperes for direct current.

(2) Driving machine motors, machine brakes, and motor-generator sets: 600 volts, except that higher potentials may be used for driving motors of motor-generator sets.

E-620.003. Live Parts Enclosed.

All live parts of electrical apparatus in the hoistways, at the landings, or in or on the cars of elevators and dumbwaiters or in the wellways or the landings of escalators shall be enclosed to protect against accidental contact.

E. Conductors

E-620.011. Insulation of Conductors.

The insulation of conductors installed in connection with elevators, dumbwaiters or escalators shall comply with the following:

(1) Control Panel Wiring. Conductors from panels to main circuit resistors

shall be flame-retardant and suitable for a temperature of not less than 90°C. (194° F.). All other wiring on control panels shall be flame-retardant, moisture-resistant.

(2) Traveling Cables. Traveling cables used as flexible connections between the elevator or dumbwaiter car and the raceway shall be Type E, EO, or ET elevator cable or other approved types and shall have a flame-retardant, moisture-resistant outer covering.

(3) Other Wiring. All conductors in the raceways and in or on the cars of elevators and dumbwaiters and in the wellways of escalators and in the machine room of elevators, dumbwaiters, and escalators shall have flame-retardant and moisture-resistant insulation.

(4) Thickness of Insulation. The thickness of the insulation of all conductors shall be suitable for the voltage to which the conductors are subjected.

E-620.012. Minimum Size of Conductors.

The minimum size of conductors used for elevator, dumbwaiter and escalator wiring, except for conductors which form an integral part of control equipment, shall be as follows:

(1) Traveling Cables.

(a) For lighting circuits: No. 14, except that No. 20 or larger conductors may be used in parallel provided the carrying capacity is equivalent to at least that of No. 14 wire.

(b) Operating control and signal circuits: No. 20.

(2) Other Wiring. All operating control and signal circuits: No. 20.

C. Wiring

E-620.021. Wiring Methods.

Conductors located in hoistways and escalator wellways, in or on cars and machine and control rooms, not including the traveling cables connecting the car and hoistway wiring, shall be installed in rigid conduit, electrical metallic tubing,

metal wireways, or Type MI cable subject to the following exceptions:

Exception No. 1. Flexible conduit or armored cable may be used in hoistways and in escalator wellways between risers and limit switches, interlocks, operating buttons, and similar devices.

Exception No. 2. Short runs of flexible conduit or armored cable may be used on cars where so located as to be free from oil and if securely fastened in place.

Exception No. 3. Types S, SO, and ST cords may be used as flexible connections between the fixed wiring on the car and the switches on car doors or gates.

Exception No. 4. Conductors between control panels and machine motors, machine brakes, and motor generator sets, not exceeding six feet in length, may be grouped together and taped or corded without being installed in a raceway provided the taping or cording is painted with an insulating paint. Such cable groups shall be supported at intervals of not more than three feet and so located as to be free from physical damage.

Note: Where motor generators and machine motors are located adjacent to or underneath control equipment, and are provided with extra length terminal leads not exceeding six feet in length, such leads may be extended to connect directly to controller terminal studs without regard to the carrying capacity requirements of chapters E-430 and E-445. Auxiliary gutters may be used in machine and control rooms between controllers, starters and similar apparatus.

D. Installation of Conductors

E-620.031. Raceway Terminal Fittings.

Conductors leaving raceways shall comply with the provisions of E-300.16. In no case shall the raceway terminate less than 6 inches from the floor.

E-620.032. Metal Wireways.

E-362.05 shall not apply to wireways. The sum of the cross-sectional area of the individual conductors in a metallic raceway shall not be more than 50 per cent of the interior cross-sectional area of the wireway.

E-620.033. Number of Conductors in Other Raceways.

The number of operating and control circuit conductors in other raceways may be in accordance with Table 1 of Chapter E-900.

E-620.034. Supports.

Supports for conductor raceways in the hoistway or escalator wellway shall be securely fastened to the guide rail or to the hoistway or wellway construction.

E-620.035. Auxiliary Gutters (Wiring Troughs).

Auxiliary gutters shall not be subject to the restrictions of E-374.02 as to length or of E-374.05 as to number of conductors.

E-620.036. Different Systems in One Raceway or Traveling Cable.

Conductors for operating, control, power, signal, and light circuits of 600 volts or less may be run in the same traveling cable or raceway system provided that all conductors are insulated for the maximum voltage found in the cables or raceway system and all live parts of the equipment are insulated from ground for this maximum voltage. Such a traveling cable or raceway may also include a pair of telephone conductors for the car telephone provided such conductors are insulated for the maximum voltage found in the cable or raceway system.

E-620.037. Wiring in Hoistways.

(1) No wires, cables or conductor enclosures shall be installed in any elevator hoistway except those needed to serve the elevator or dumbwaiter equipment including wiring for heating, ventilating, and lighting the car or hoistway, wiring for signals, for communication with the car, for a work light and convenience outlet approximately level with the lowest terminal landing floor and for fire detection systems.

(2) Other wires, cables, or conductor enclosures may in exceptional cases be installed in the elevator or dumbwaiter, hoistway only if approved in writing by the Industrial Commission provided that no opening, terminal, outlet or junction box is within the hoistway and shall be continuous between outlets or terminals entirely outside the hoistway.

Note: It is not intended to prohibit the interruption of long runs for the purpose of supporting or pulling in conductors, and pull boxes may be installed for this purpose.

E. Traveling Cables

E-620.041. Suspension

(1) Traveling cables shall be so suspended at the car and hoistway end as to reduce the strain on the individual copper conductors to a minimum.

(2) Cables exceeding 100 feet in length and which have steel supporting fillers shall be suspended directly by the steel supporting fillers.

(3) Where non-metallic fillers are used, the cables shall be suspended by looping the cables around the supports.

E-620.042. Hazardous Locations.

In hazardous locations, traveling cables shall be Type EO and shall be secured to explosion proof cabinets by heavy-duty rubber-bushed threaded connector bushings sealed off at the enclosure as provided in E-501.05.

E-620.043. Location of and Protection for Cables.

Traveling cable supports shall be so located as to reduce to a minimum the possibility of damage due to the cables coming in contact with the hoistway construction or equipment in the hoistway. Where necessary, suitable guards shall be provided to protect the cables against damage.

F. Control

E-620.051. Disconnecting Means.

(1) Externally operated circuit-breaker or fused switch of the enclosed type opening all lines shall be installed separately in the supply circuit of every elevator or escalator. This breaker or switch shall be provided with proper overcurrent protection, and shall be located in the machine room on the lock-jamb side of the entrance door and be visible from the elevator machine. This breaker or switch shall not be made to close from any other part of the building. The switch shall be a horsepower rated motor circuit switch for motors up to

and including 50 HP.

(2) For power dumbwaiters, the circuit breaker or disconnect switch shall be located adjacent to the controller which shall be mounted on the outside of the hoistway on the hoistway wall.

E-620.052. Electrical Equipment in Garages and Similar Occupancies.

Electrical equipment and wiring used for elevators, dumbwaiters and escalators in garages shall conform to the requirements of Chapter E-511. Wiring and equipment located under the car platform shall be considered as being located in the hazardous area.

E-620.053. Phase Protection.

Elevators driven by polyphase alternating current machine motors shall be provided with means to prevent starting of the elevator motor when:

- (1) The phase rotation is in the wrong direction, or
- (2) There is a failure in any phase.

G. Overcurrent Protection

E-620.061. Overcurrent Protection.

Overcurrent protection shall be provided as follows:

(1) Control and Operating Circuits. Control and operating circuits and signal circuits shall be protected against overcurrent in accordance with the requirements of E-725.18.

(2) Motors.

(a) Duty on elevator, dumbwaiter, and driving motors of generator sets used with generator field control shall be classed as intermittent. These motors shall be protected against overcurrent in accordance with E-430.033.

(b) Duty on escalator motors shall be classed as continuous. These motors shall be protected against overcurrent in accordance with E-430.032.

H. Machine Room

E-620.071. Guarding Equipment.

(1) Elevator, dumbwaiter and escalator driving machines, motor generator sets, controllers and auxiliary control equipment shall be installed in a space secured against unauthorized access.

(2) Such equipment may be located in rooms or spaces containing other equipment essential to the operation of the building provided it is separated therefrom by a substantial metal grille enclosure of a design which will reject a ball two inches in diameter and is at least six feet high equipped with a self-closing and self-locking door.

(3) It is not intended to prohibit the installation of dumbwaiter or escalator controllers outside the spaces herein specified, provided they are enclosed in cabinets with doors or removable panels capable of being locked in the closed position; nor is it intended to prevent the installation of dumbwaiter controllers within the hoistway without cabinets, provided removable or hinged panels capable of being locked in the closed position are installed in the hoistway enclosures to provide access to the controllers.

E-620.072. Clearance Around Control Panels.

(1) There shall be provided sufficient clear working space around control panels to provide safe and convenient access to all live parts of the equipment necessary for maintenance and adjustment. The minimum clear working space about live parts on control panels shall not be less than set forth in E-620.072⁽¹⁾ (a) and (b) unless otherwise specified.

(a) Elevator and Dumbwaiter Panels.

1. In the front - 30 inches to live panel parts.
2. In the rear - 24 inches to live panel parts.
3. On one side of a panel or a group of panels - 18 inches except this clearance can be waived if there is a clear passageway, not less than 18 inches wide at any point, from the front to the rear of the panel or panels.

Note 1. It shall be permissible to mount control panels on, over or against the hoisting machine or motor generator set or to place auxiliary control equipment in the front or rear of control panels provided the clearances to the live parts are not less than specified and provided there is safe access to the front and/or back

of the controller from at least one side.

Note 2. Where control panels are mounted in cabinets with swing doors or removable panels, sufficient clear space shall be provided to fully open the doors or remove the panels.

(b) Escalator Control Panels.

1. The minimum working clearance for escalator control panels shall be as specified in E-620.072⁽¹⁾(a) provided that where the control panel is mounted in the same space as the escalator drive machine and the clearances specified cannot be provided, they may be waived where the entire panel is arranged so that it can be readily removed from the machine space and is provided with flexible leads to all external connections.

2. Where control panels are not located in the same space as the drive machine they shall be so located in cabinets with doors or removable panels capable of being locked in the closed position. Such cabinets may be mounted in the balustrading on the side away from the moving steps.

J. Grounding

E-620.081. Metal Raceways Attached to Cars.

Conduit or armored cable attached to elevator cars shall be bonded to grounded metal parts of the car with which they come in contact.

E-620.082. Electric Elevators.

For electric elevators, the frames of all motors, elevator machines, controllers and the metal enclosures for all electrical devices in or on the car or in the hoistway shall be grounded.

E-620.083. Non-Electric Elevators.

For elevators other than electric, when any electrical conductors are attached to the car, the metal frame of the car, where normally accessible to persons, shall be grounded.

E-620.084. Hand-Operated Cables.

All hand-operated metallic shifting ropes or cables shall be grounded.

E-620.085. Inherent Ground.

Equipment mounted on members of the structural metal frame of a building shall be deemed to be grounded. Metal car frames supported by metal hoisting cables attached to or running over sheaves or drums of elevator machines shall be deemed to be grounded when the machine is grounded in accordance with Chapter E-250.

K. Overspeed

E-620.091.- Power Rectifiers for Direct Current Elevators.

Where dry plate rectifiers or other types of rectifiers which are incapable of absorbing electrical energy are used to transform alternating current to direct current for the operation of a direct current elevator motor or motors, means shall be provided to absorb a sufficient amount of the energy regenerated by the elevator motor or motors under overhauling load conditions to prevent any elevator from attaining at any time a speed of more than 125 per cent of its rated speed (speed in the up direction with rated load in the car).

E-620.092. Motor Generator Overspeed Device.

Motor generators driven by direct current motors and used to supply direct current for the operation of elevator machine motors shall be provided with speed limiting devices as required by E-430.089 (3), which will prevent the elevator from attaining at any time a speed of more than 125 per cent of its rated speed.

L. Lighting

E-620.101. Lighting.

The following required lights and convenience outlets are in addition to those required in the car (See Ind 4.76 of the Wisconsin Administrative Code):

(1) Landing Light. Every elevator hoistway landing within or in connection with an occupied building shall be provided with sufficient light to clearly see small objects at the threshold.

(2) Machine Rooms and Overhead Lighting. Every machine room shall be provided with artificial lighting having an intensity of not less than 2-foot candles at the floor. Every area about a ceiling type machine, including overhead sheave rooms or lofts, shall be amply lighted. Control of such lighting shall be in the approach to the machine room or overhead equipment.

(3) Work Lights. Every power elevator hereafter installed shall be equipped with a work light and convenience outlet located in the hoistway approximately level with the lowest terminal landing floor if hoistway landing doors are used.

CHAPTER E-630
ELECTRIC WELDERS

A. General

E-630.01. Scope.

This Chapter covers extensively used types of welders which require special treatment, as distinguished from welders which do not require special treatment and welders not in common use and not yet developed to the extent that rating and construction standards are possible.

E-630.02. Other Chapters.

This Chapter amplifies or modifies parts of Chapters E-100 to E-400 inclusive of this Code in order to properly cover the operating conditions to which electric welder installations are subjected. Accordingly the appropriate provisions of Chapters E-100 to E-400 inclusive apply to the component parts of electric welder installations except as otherwise provided in this Chapter.

B. Transformer Arc Welders

E-630.11. Capacity of Supply Conductors.

The current-carrying capacity of conductors shall be as follows:

(1) Individual Welders. The rated current-carrying capacity of the supply conductors shall be not less than the rated primary current of the welder.

(2) Group of Welders. The rated current-carrying capacity of conductors which supply a group of welders may be less than the sum of the rated primary currents of the welders supplied. The conductor rating shall be determined in each case according to the welder loading based on the use to be made of each welder and the allowance permissible in the event that all the welders supplied by the conductors will not be in use at the same time. The load value used for each welder shall take into account both the magnitude and the duration of the load while the welder is in use.

Note: Conductor ratings based on 100 per cent of the rated primary current of the two largest welders, 85 per cent for the third largest welder, 70 per cent for

the fourth largest welder, and 60 per cent of the rated primary current for all the remaining welders, should provide an ample margin of safety under high production conditions with respect to the maximum permissible temperature of the conductors. Percentage values lower than those given are permissible in cases where the work is such that a high operating duty cycle for individual welders is impossible.

E-630.12. Overcurrent Protection.

Overcurrent protection shall be as provided in E-630.12(1) and (2). Where the nearest standard rating of the overcurrent device used is under the value specified in this rule, or where the rating or setting specified results in unnecessary opening of the overcurrent device, the next higher rating or setting may be used.

(1) For Welders. Each welder shall have overcurrent protection rated or set at not more than 200 per cent of the rated primary current of the welder, except that an overcurrent device is not required for a welder having supply conductors protected by an overcurrent device rated or set at not more than 200 per cent of the rated primary current of the welder.

(2) For Conductors. Conductors which supply one or more welders shall be protected by an overcurrent device rated or set at not more than 200 per cent of the conductor rating.

E-630.13. Controller.

A controller shall be provided in the supply connection of each welder which is not equipped with a controller mounted as an integral part of the welder. The controller shall be a motor-circuit switch or a circuit-breaker. The ampere rating shall be not less than the rated primary current of the welder. The horsepower rating of a switch used as a controller shall be not less than the numerical value obtained by multiplying the rated primary current of the welder by 0.1, 0.2 or 0.25, respectively, for 220-, 440- and 550-volt welders. These factors apply to 2-pole switches.

E-630.14. Marking.

A nameplate giving the following information shall be provided: name of manufacturer; frequency; primary voltage; rated primary current; maximum open-circuit secondary voltage; rated secondary current; basis of rating, i.e., the duty cycle, 30-minute rating or 60-minute rating.

C. Motor-Generator Arc Welders

E-630.21. Other Rules Which Apply.

Motor-generator arc welder installations are covered by the appropriate rules of Chapters E-100 to E-400 inclusive applicable to conductors, motors, generators and associated equipment. Referring specifically to the motor supply connections, the following rules apply in addition to such other provisions as may be applicable. Conductor rating, E-430.022 and E-430.026. Overcurrent protection for motors, E-430.033; for conductors, E-430.052. Controllers, E-430.007, E-430.008 and E-430.083. Disconnecting means, E-430.111.

D. Resistance Welders

E-630.31. Capacity of Supply Conductors.

The current-carrying capacity of the supply conductors necessary to limit the voltage drop to a value permissible for the satisfactory performance of the welder is usually greater than that required to prevent over-heating as prescribed in E-630.31(1) and (2).

(1) Individual Welders. The rated current-carrying capacity for conductors for individual welders shall conform to the following:

(a) Varving Operations. The rated current-carrying capacity of the supply conductors for a welder which may be operated at different times at different values of primary current or duty cycle shall be not less than 70 per cent of the rated primary current for seam and automatically fed welders, and 50 per cent of the rated primary current for manually-operated non-automatic welders.

(b) Specific Operation. The rated current-carrying capacity of the supply conductors for a welder wired for a specific operation for which the actual

primary current and duty cycle are known and remain unchanged shall be not less than the product of the actual primary current and the multiplier given below for the duty cycle at which the welder will be operated.

Duty Cycle										
(per cent)	50	40	30	25	20	15	10	7.5	5.0 or less	
Multiplier .....	.71	.63	.55	.50	.45	.39	.32	.27	.22	

(2) Groups of Welders. The rated current-carrying capacity of conductors which supply two or more welders shall be not less than the sum of the value obtained as explained in E-630.31(1) for the largest welder supplied, and 60 per cent of the values obtained as explained in E-630.31(1) for all the other welders supplied.

(3) Explanation of Terms. (a) The rated primary current is the rated kva multiplied by 1,000 and divided by the rated primary voltage, using values given on the nameplate. (b) The actual primary current is the current drawn from the supply circuit during each welder operation at the particular heat tap and control setting used. (c) The duty cycle is the percentage of the time during which the welder is loaded. For instance, a spot welder supplied by a 60-cycle system (216,000 cycles per hour) making four hundred 15-cycle welds per hour would have a duty cycle of 2.8 per cent (400 multiplied by 15, divided by 216,000, multiplied by 100). A seam welder operating 2 cycles "on" and 2 cycles "off" would have a duty cycle of 50 per cent.

E-630.32. Overcurrent Protection.

Overcurrent protection shall be as provided in E-630.32(1) and (2). Where the nearest standard rating of the overcurrent device used is under the value specified in this rule, or where the rating or setting specified results in unnecessary opening of the overcurrent device, the next higher rating or setting may be used.

(1) For Welders. Each welder shall have an overcurrent device rated or set at not more than 300 per cent of the rated primary current of the welder, except that an overcurrent device is not required for a welder having a supply circuit protected by an overcurrent device rated or set at not more than 300 per cent of the rated

primary current of the welder.

(2) For Conductors. Conductors which supply one or more welders shall be protected by an overcurrent device rated or set at not more than 300 per cent of the conductor rating.

E-630.33. Disconnecting Means.

A switch or circuit-breaker shall be provided by which each welder and its control equipment can be isolated from the supply circuit. The current-carrying capacity of this disconnecting means shall be not less than the supply conductor rating determined as explained in this Chapter. The supply circuit switch may be used as the welder disconnecting means where the circuit supplies only one welder.

E-630.34. Marking.

A nameplate giving the following information shall be provided: name of manufacturer, frequency, primary voltage, rated kva at 50 per cent duty cycle, maximum and minimum open-circuit secondary voltage, short-circuit secondary current at maximum secondary voltage and specified throat and gap setting.

CHAPTER E-640

SOUND-RECORDING AND SIMILAR EQUIPMENT

E-640.01. Scope.

This Chapter shall apply to installations of equipment and wiring used for sound-recording and reproduction, centralized distribution of sound, public address, speech-input systems and electronic organs.

E-640.02. Application of Other Chapters.

(1) Except as modified by this Chapter, wiring and equipment from source of power to and between devices connected to the interior wiring systems shall comply with the requirements of Chapters E-100 to E-400, inclusive, of this code.

(2) Wiring and equipment for public-address, speech-input, radio-frequency, audio-frequency systems, and amplifying equipment associated with radio receiving stations in centralized distribution systems, shall comply with Chapter E-725.

E-640.03. Number of Conductors in Raceway.

The number of conductors in a conduit or other raceway shall comply with Tables 1 to 7 inclusive of Chapter E-900 except as follows:

Exception No. 1. Special permission may be granted for the installation of two 2-conductor lead-covered cables in $\frac{3}{4}$ -inch conduit, provided the cross-sectional area of each cable does not exceed .11 square inch.

Exception No. 2. Special permission may be granted for the installation of two 2-conductor No. 19 lead-covered cables in $\frac{1}{2}$ -inch conduit, provided the sum of the cross-sectional areas of the cables does not exceed 32 per cent of the internal cross-sectional area of the conduit.

E-640.04. Wireways and Auxiliary Gutters.

(1) Wireways and auxiliary gutters shall comply with the requirements of Chapters E-362 and E-374.

(2) Where used for sound-recording and reproduction the following exceptions are made:

Exception No. 1. Number of Conductors in Raceway. Conductors in wireways or gutters shall not fill the raceway to more than 75 per cent of its depth.

Exception No. 2. Auxiliary-Gutter Covers. Where the cover of auxiliary gutters is flush with the flooring and is subject to the moving of heavy objects it shall be of steel at least $\frac{1}{4}$ -inch in thickness; where not subject to moving of heavy objects, as in the rear of patch or other equipment panels, the cover shall be at least No. 10 MS (USS Revised) gauge.

Exception No. 3. Metal-Trough Raceways. Metal-trough raceways may be installed in concealed places provided they are run in a straight line between outlets or junction boxes. Covers of boxes must be accessible. Edges of metal must be rounded at outlet or junction boxes and all rough projections smoothed to prevent abrasion of insulation or conductors. Raceways made of sections shall be bonded and grounded as prescribed in E-250.076.

Exception No. 4. Grounding Wireways and Auxiliary Gutters. Metal wireways and auxiliary gutters shall be grounded in accordance with the requirements of Chapter E-250. Where the wireway or auxiliary gutter does not contain power supply wires, the grounding conductor need not be larger than No. 14 copper or its equivalent. Where the wireway or auxiliary gutter contains power supply wires, the grounding conductor shall not be smaller than the size called for in E-250.095.

E-640.05. Conductors.

Amplifier output circuits carrying audio-program signals of 70 volts or less and whose open circuit voltage will not exceed 100 volts, may employ Class 2 wiring as covered in Chapter E-725.

Note: The above is based on amplifiers whose open-circuit voltage will not exceed 100 volts when driven with a signal at any frequency from 60 to 100 cps sufficient to produce rated output (70.7 volts) into its rated load. This also accepts the known fact that the average program material is 12 db below the amplifier rating - thus the average RMS voltage for an open-circuit 70 volt output would be only 25 volts.

E-640.06. Grouping of Conductors.

Conductors of different systems grouped in the same conduit or other metallic enclosure, or in portable cords or cables, shall comply with the following requirements:

(1) Power-Supply Conductors. Power-supply conductors shall be properly indicated and shall be used solely for supplying power to the equipment to which the other conductors are connected.

(2) Leads to Motor-Generator or Rotary Converter. Input leads to a motor-generator or rotary converter shall be run separately from the output leads.

(3) Conductor Insulation. The conductors shall be insulated individually, or collectively in groups, by insulation at least equivalent to that on the power-supply and other conductors.

Exception: Where the power-supply and other conductors are separated by a lead sheath or other continuous metallic covering.

E-640.07. Flexible Cords.

Flexible cords and cables shall be of types P, K, S, SJ, ST, SJO, and SJT or other types specifically approved for the purpose for which they are to be used. The conductors of flexible cords, other than power-supply conductors, may be of a size not smaller than No. 26 provided such conductors are not in direct electrical connection with the power-supply conductors and are equipped with current-limiting means so that the maximum power under any condition will not exceed 150 watts.

E-640.08. Terminals.

Terminals shall be marked to show their proper connections. Terminals for conductors other than power-supply conductors shall be separated from the terminals of the power-supply conductors by a spacing at least as great as the spacing between power-supply terminals of opposite polarity.

E-640.09. Storage Batteries.

Storage batteries shall comply with the following:

(1) Installation. Storage batteries shall be installed in accordance with Chapter E-480.

(2) Conductor Insulation. Storage-battery leads shall be rubber-covered or thermoplastic-covered.

E-640.10. Overcurrent Protection of "A", "B" and "C" Circuits.

Overcurrent protection shall be provided as follows:

(1) "A" circuit, where supplied by branch-lighting circuits, or by storage batteries of more than 20-ampere-hour capacity, shall have overcurrent protection not exceeding 15 amperes.

(2) "B" circuits shall have overcurrent protection not exceeding one ampere. The overcurrent protection shall be placed in each positive lead.

(3) "C" circuits where supplied from branch lighting circuits or from storage batteries of more than 20-ampere-hour capacity shall have overcurrent protection not exceeding one ampere.

(4) Overcurrent devices shall be located as near as practicable to the battery.

E-640.11. Amplifiers and Rectifiers - Type.

(1) They shall be suitably housed and shall be of a type approved for the purpose unless otherwise expressly permitted by the administrative authority.

(2) Amplifiers and rectifiers shall be so located as to be readily accessible.

(3) Amplifiers and rectifiers shall be so located as to provide sufficient ventilation to prevent undue temperature rise within the housing.

E-640.12. Hazardous Locations.

Equipment used in hazardous locations shall be specifically approved for the purpose.

E-640.13. Protection Against Physical Damage.

Amplifiers, rectifiers, loud-speakers and other equipment shall be so located or protected as to guard against physical damage such as might result in fire or personal hazard.

CHAPTER E-650

ORGANS

E-650.01. General.

This Chapter shall apply to those electric circuits and parts of electrically operated organs which are employed for the control of the sounding apparatus and keyboards. Electronic organs shall comply with the appropriate provisions of Chapter E-640.

E-650.02. Source of Energy.

The source of energy shall have a potential of not over 15 volts and shall be a self-excited generator, a two-coil-transformer type rectifier or a primary battery.

E-650.03. Insulation - Grounding.

The generator shall be effectively insulated from the ground and from the motor driving it, or both the generator and the motor frames shall be grounded in the manner prescribed in Chapter E-250.

E-650.04. Conductors.

Conductors shall comply with the following:

- (1) Size. No conductor shall be smaller than No. 26, and the common-return conductor shall be not smaller than No. 14.
- (2) Insulation. Conductors shall have rubber, thermoplastic, asbestos, cotton, or silk insulation, except the common-return conductor which shall be rubber-covered, thermoplastic, asbestos-covered (types AA, AI, or AIA), or slow-burning (type SB). The cotton or silk may be saturated with paraffin if desired.
- (3) Conductors to be Cabled. Except the common-return conductor, and conductors inside the organ proper, the organ sections and the organ console, conductors shall be cabled. The common-return conductor may be placed under an additional covering enclosing both cable and return conductor, or may be installed as a separate conductor and may be in contact with the cable.
- (4) Cable Covering. The cable shall be provided with one or more braided outer

coverings, provided that a tape may be used in place of an inner braid. Where not installed in metal raceways the outer braid shall be flame-retardant or shall be covered with a closely-wound fireproof tape.

E-650.05. Installation of Conductors.

Cables shall be securely fastened in place and may be attached directly to the organ structure without insulating supports. Cables shall not be placed in contact with other conductors.

E-650.06. Overcurrent Protection.

Circuits shall be so arranged that all conductors, except the main supply conductors and the common-return conductor, shall be protected from over-current by an overcurrent device of not greater than 15-ampere rating.

CHAPTER E-660

X-RAY EQUIPMENT

A. Scope and Installation

E-660.01. Scope.

The provisions of this Chapter shall apply to all X-ray equipment operating at any frequency or voltage for medical or industrial use, or for any other purpose.

Note 1. Nothing in this Chapter shall be construed as specifying safeguards against the useful beam or stray X-ray radiation.

Note 2. Recommendations for radiation protection by the National Committee on Radiation Protection and Measurement are published as National Bureau of Standards Handbooks obtainable from Superintendent of Documents, Washington 25, D. C.

Note 3. Recommendations for radiation protection of industrial X-ray installations by the American Standard Association Z 54 Sectional Committee are obtainable from the American Standards Association, New York 17, New York.

E-660.02. Hazardous Locations or 600 Volt Supply.

Unless approved for the location, X-ray and related equipment shall not be installed or operated in hazardous locations or operated on a supply potential of more

than 600 volts.

E-660.03. Connection to Supply Circuit.

(1) Stationary Equipment. X-ray equipment permanently installed shall be connected to the power supply by means of a wiring method meeting the general requirements of this code, except that equipment properly supplied by branch circuits not larger than a 30-ampere branch circuit may be supplied through suitable plug and hard service cable or cord.

(2) Portable and Transportable. Portable type X-ray equipment of any capacity shall be supplied through a suitable plug and hard service cable or cord. Transportable X-ray equipment of any capacity may be connected to its power supply by suitable temporary connections and hard service cable or cord.

E-660.04. Disconnecting Means.

(1) A fused disconnecting means or manually operable circuit-breaker of adequate capacity for at least 50 per cent of the input required for the momentary rating of the X-ray equipment shall be provided in the supply circuit at a location readily accessible from the X-ray control. For equipment requiring 125-volt line fuses of 30 ampere or less a plug and receptacle of proper size and of an approved make may serve as a disconnecting means. Individual branch circuit disconnecting means shall not be required for portable X-ray equipment of any capacity which complies with E-660.10.

Definitions:

Continuous rating. Continuous rating is a constant load which can be carried for an indefinite period of time.

Long time rating. A long time rating is the rating based on an operating interval of 5 minutes or longer.

Momentary rating. A momentary rating is the rating based on an operating interval that does not exceed 5 seconds.

(2) The capacity of the branch circuit conductors and the ratings of disconnecting means and overcurrent protection for X-ray equipment is usually recommended

by the manufacturer for the specific installation.

E-660.05. Wiring Terminals.

Unless provided with a permanently attached cord or a cord set, X-ray equipment shall be provided with suitable wiring terminals or leads for the connection of conductors of at least the size required by the input load corresponding to the long time rating of the equipment.

E-660.06. Number of Conductors in Raceway.

The number of control circuit conductors installed in a raceway may be in accordance with Table 1 of Chapter E-900.

E-660.07. X-ray Installations.

(1) Shockproof Installations. All new equipment used on new installations of X-ray equipment, or used or reconditioned equipment moved to and re-installed at a new location shall be of the approved shockproof type, except as provided for in E-660.07(2). All controls, tables, X-ray tube stands, transformer tanks, shockproof cables, and X-ray tube heads, etc. shall be suitably grounded to prevent accidental shock to patient or operator.

(2) Non-Shockproof Re-installations. No non-shockproof X-ray equipment shall be re-installed in a new location without special permission from the administrative authority. Any such equipment shall be re-installed in an approved manner.

E-660.08. On Fluoroscopic Tables.

Where permitted in accordance with E-660.07(2), leads on fluoroscopic tables shall be adequately insulated or be provided with barriers which will guard against inadvertent contact.

B. Control

E-660.09. Stationary Equipment.

A manually controlled device shall be incorporated in the X-ray control supply or in the primary circuit to the high voltage transformer, and shall be adequate to control the load resulting from failures in the high voltage circuit. This device

shall be a part of the X-ray equipment, but may be located in a separate enclosure immediately adjacent to the X-ray control unit.

E-660.10. Portable Equipment.

Portable equipment shall comply with E-660.09, but the manually controlled device shall be located in or on the equipment.

E-660.11. General.

(1) Radiographic Type. There shall be provided a timer or automatic exposure terminating device and also a switch of a type which opens automatically except when held closed by the operator.

(2) Fluoroscopic Type. A switch shall be provided which shall be designed to open automatically except when held closed by the operator.

(3) Therapy. A timer or automatic exposure terminating device shall be provided which is not of the repeating type.

C. Industrial Apparatus

E-660.12. Industrial X-ray Apparatus.

(1) Radiographic and Fluoroscopic Types. A switch which shall be designed to open automatically except when held closed by the operator, or a timer, shall be provided except on equipment or installations effectively enclosed or provided with interlocks to prevent ready access to live current-carrying parts during operation.

(2) Industrial or Laboratory Apparatus - Diffraction or Irradiation Types. Positive indication of energization by pilot lights, readable meter deflections or equivalent means shall be provided except on equipment or installations effectively enclosed or provided with interlocks to prevent ready access to live current-carrying parts during operation.

E-660.13. Foot Switch.

Switches operated by foot pressure to control the X-ray exposure shall return automatically to the X-ray off position when foot pressure is removed.

E-660.14. Independent Control.

Where more than one piece of apparatus is operated from the same high-voltage circuit, each piece or each group of apparatus as a unit shall be provided with a high-voltage switch or equivalent disconnecting means. This disconnecting means shall be constructed, enclosed, or located so as to avoid contact by persons with its live parts.

D. Transformers and Capacitors

E-660.15. General.

Transformers and capacitors which are part of an X-ray apparatus shall not be required to conform to the requirements of Chapters E-450 and E-460 of this code.

E-660.16. Draining Capacitor Charge.

Capacitors shall be provided with an automatic means for discharge and grounding the plates whenever the transformer primary is disconnected from the source of supply.

Exception No. 1. Where all current-carrying parts of capacitors, and ^{of} the conductors connected therewith, are at least 8 feet from the floor and are inaccessible to unauthorized persons.

Exception No. 2. Where within 8 feet from the floor are within enclosures of grounded metal or insulating material.

E. Guarding and Grounding

E-660.17. General.

(1) High Voltage Parts. All high voltage parts, including X-ray tubes, shall be mounted within grounded enclosures. Either air, oil, gas or other suitable insulating media may be used to insulate the high voltage from the grounded enclosure. The connections from the high voltage equipment to X-ray tubes and other high voltage components shall be made with high voltage cables of the shockproof type.

(2) Low Voltage Cables. Low voltage connecting cables to oil filled units such as transformers, condensers, oil coolers, and high voltage switches which are not completely sealed shall be of the oil resistant type.

E-660.18. Grounding.

Non-current-carrying metal parts of tube stands, fluoroscopic and other equipment shall be grounded in the manner prescribed in Chapter E-250.

(1) Portables. Portable equipment shall be provided with an approved grounding type plug.

CHAPTER E-665

INDUCTIVE AND DIELECTRIC HEAT GENERATING EQUIPMENT

A. Scope and General

E-665.01. Scope.

The provisions of this Chapter shall apply to the construction and installation of inductive and dielectric heat-generating equipment and accessories.

E-665.02. Definitions.

(1) The term "generating equipment" as used in this Chapter shall be understood to mean any equipment used to change the voltage and/or frequency of the power supplied to such equipment.

(2) Inductive heating is the heating of a nominally conducting material due to its own I^2R losses when the material is placed in a varying electro-magnetic field.

(3) Dielectric heating is the heating of a nominally insulating material due to its own dielectric losses when the material is placed in a varying electric field.

(4) The term "therapeutic high frequency equipment" as used in this Chapter shall be understood to mean generating equipment capable of producing alternating currents having frequencies greater than those frequencies which elicit neuromuscular response. In order to comply with the above, the output frequency of the therapeutic high frequency equipment shall not be less than 2 megacycles.

E-665.03. Application of Other Chapters.

Wiring from the source of power to generating equipment shall comply with code

Chapters E-100 to E-400 inclusive. Circuits and equipment operating on a supply circuit of more than 600 volts shall comply with the provisions of Chapter E-710.

E-665.04. Hazardous Locations.

Inductive and dielectric heat generating equipment shall not be installed in hazardous locations as defined in Chapter E-500 unless the equipment is designed and approved for hazardous locations.

B. Power Supply

E-665.05. Capacity of Supply Conductors.

(1) For Motor Generator Equipment. Capacity of supply conductors shall be determined from Chapter E-430 of this code.

(2) For Other Than Motor Generator Equipment. Capacity of supply conductors shall be determined as follows:

(a) The current-carrying capacity of the circuit shall be not less than the nameplate current rating of the equipment.

(b) The current-carrying capacity of conductors supplying two or more equipments shall be not less than the sum of nameplate current ratings on all equipment except as follows: Where, when supplying two or more equipments from the same feeder, simultaneous operation of said equipments is not possible, the capacity of the feeder shall be not less than the sum of the nameplate currents for the largest group of machines capable of simultaneous operation, plus 100 per cent of the standby currents of the remaining machines supplied.

E-665.06. Overcurrent Protection.

(1) For Motor Generator Equipment. Overcurrent protection shall be provided as specified in Chapter E-430 of this code.

(2) Other Than Motor Generator Equipment. Overcurrent protection shall be provided separately or as part of the equipment, to protect the equipment as a whole. The overcurrent device shall have a rating or setting of not more than 200 per cent of the nameplate current rating.

E-665.07. Disconnecting Means.

A readily accessible disconnecting means shall be provided by which each generating equipment can be isolated from the supply circuit. The current-carrying capacity of this disconnecting means shall be not less than the nameplate current rating of equipment. The supply circuit switch may be used as the generating equipment disconnecting means where the circuit supplies only one equipment.

C. Output

E-665.08. Output Circuit Definition.

Output circuit parts shall include all high frequency components external to the generator, including interconnecting radio frequency transmission lines, load tuning networks, and work applicators.

E-665.09. Output Circuits.

Output circuits shall conform to the following:

- (1) Guarding. With respect to guarding, all such parts shall be considered with the generating equipment as a complete assembly.
- (2) Generator Output. The generator output shall be at direct-current ground potential (coupled outputs alone, without other precautions, will not suffice because of the danger existing during possible flashovers).
- (3) Generator and Applicator Connection. When the connections between the generator and work applicator exceed two feet in length the connections shall be enclosed or guarded with non-combustible material.
- (4) Work Applicator. The work applicator shall be so guarded that safe operation of the equipment will always be assured.

E-665.10. Low Frequency AC in Generating Equipment Output.

Commercial frequencies of 25 to 60 cycle alternating-current output may be coupled for control purposes, but shall be limited to a value of 150 volts available^{only} during periods of circuit operation.

E-665.11. Keying.

Where high speed keying circuits / dependent on the effect of "oscillator blocking" are employed, the peak RF output voltage during the blocked portion of the cycle shall not exceed 100 volts.

E-665.12. Foot Switch.

Switches operated by foot pressure, except those for electro-surgical apparatus, shall be provided with a shield over the contact button to avoid accidental closing.

E-665.13. Remote Control.

When remote controls are used for applying power, a "Local-Remote" switch shall be provided and interlocked so as to prevent the possibility of applying power from other than one selected control point or points.

D. Guarding and Grounding

E-665.14. Warning Labels.

Warning labels, definitely indicating danger, shall be attached to doors, access panels or at other vantage points on equipment, so that the labels will be plainly visible when doors are opened or panels are removed from compartments containing voltages above 250 volts AC or DC.

E-665.15. Enclosure of Generating Apparatus.

The generating apparatus including the DC, low-, and high-frequency electrical circuits but excluding the output circuits shall be completely contained in an enclosure of noncombustible material. The metal housings of motors, generators and the like may serve as a part of this enclosure.

E-665.16. Panel Controls.

All panel controls shall be of "dead front" construction.

E-665.17. Access to Internal Equipment.

Doors or detachable panels may be employed for internal access. Where doors are used, giving access to voltages above 500 volts AC or DC either door locks shall be provided or interlocking shall be installed with the choice of precaution optional. Detachable panels not normally used for access to such parts shall be fastened in a manner not conveniently removable.

E-665.18. Capacitors.

(1) Where capacitors in excess of 0.1 Mfd. are used in DC circuits, either as

rectifier filter components, arc suppressors, etc., having circuit voltages exceeding 230 volts above ground, bleeder resistors or grounding switches shall be used as grounding devices.

(2) Where auxiliary rectifiers are used with filter capacitors in the output for bias supplies, tube keyers, etc., bleeder resistors shall be used even though the DC voltage may not exceed 230 volts.

E-665.19. Work Applicator Shielding.

Protective cages or adequate shielding shall be used to guard work applicators. Interlock switches shall be used on all hinged access doors, sliding panels or other easy access means normally intended for quick access to the applicator. All interlock switches shall be connected in such a manner as to remove all power from the applicator when any one of the access doors or panels is open.

E-665.20. Grounding and Bonding.

Grounds or inter-unit bonding shall be used wherever required for circuit operation and for limiting to a safe value radio frequency potentials between all exposed non-current-carrying parts of the equipment and earth ground, also between all equipment parts and surrounding objects and between such objects and earth ground. Such grounding and bonding shall be installed in accordance with Chapter E-250 of this code.

E-665.21. Marking.

Each generating equipment shall be provided with a nameplate giving the manufacturers' name and model identification and the following input data: line volts, frequency, number of phases, maximum current, full load kva, and power factor.

E. Therapeutic Equipment

E-665.22. Installation.

(1) Where portability is not essential, equipment shall be permanently installed in accordance with Chapters E-100 to E-300 inclusive.

(2) Where portability is essential, the power supply cord shall be three-conductor hard service cord of such current-carrying capacity as to be not less than the

marked rating of the equipment, and it shall be provided with one conductor whose insulation is green in color for equipment grounding. Where the marked rating of the equipment exceeds 15 amperes the cord shall terminate in an approved three-blade attachment-plug cap. Where the marked rating of the appliance does not exceed 15 amperes the cord may be terminated in an approved two-blade attachment-plug cap with grounding wire. (See E-250.059).

E-665.23. Applicators for Therapeutic Equipment.

Application of the high frequency power to the patient may be made by means of an electric field or of an induction field. Current-carrying parts of applicators shall be so insulated or enclosed that reliable isolation of the patient shall be assured.

CHAPTER E-670

MACHINE TOOLS

A. General

E-670.01. Scope.

The provisions of this Chapter apply to the electrical equipment for motor-driven, complete metalworking machines, not portable by hand, having one or more tool and work holding devices used for progressively removing metal in the form of chips.

E-670.02. Application of Other Chapters.

The following provisions cover the requirements for electrical wiring and equipment on machine tools within the scope of this Chapter. They are in addition to or amendatory of the applicable provisions of other Chapters of this code which apply except as modified in this Chapter.

E-670.03. Identification.

Each electrically operated machine tool shall be marked where plainly visible to show the voltage, full-load current and frequency required for each external circuit supplying the machine tool. For a multi-motored machine tool, this full-load current marking shall be not less than the sum of the full-load currents required for

all motors which may be in operation at one time under normal conditions of use. Where only a single motor is used, the motor nameplate may serve when plainly visible.

E-670.04. Lighting.

Lighting fixtures which are a part of or attached to any machine tool shall conform to the following:

(1) Voltage. The lighting circuit voltage shall not exceed 150 volts between conductors and shall be a grounded circuit.

(2) Flexible Cord. Flexible cord if used shall be of a type suitable for hard usage (see Table E-400.11), and shall be resistant to coolant and oil. It shall be arranged so it cannot be damaged by moving parts of the machine.

B. Wiring Method

E-670.11. Wiring Method.

Conductors shall be in rigid metal conduit or be Type MI cable, except as provided in E-670.12 to E-670.14 inclusive.

E-670.12. Flexible Metal Conduit.

Flexible metal conduit, including the liquid-tight type, may be used only where necessary to employ flexible connections for small or infrequent movements, as at motor terminals.

E-670.13. Continuously Moving Parts.

Wiring connections to continuously moving parts of a machine tool shall be of approved type, extra-flexible, non-metallic-covered, multi-conductor cable. Conductors shall conform to E-670.22. In lieu of cable, individual conductors enclosed in flexible tubing may be used. The tubing and its fittings shall be approved for the purpose, and conductors in such tubing shall be considered as subject to oil or coolant.

E-670.14. Compartments and Raceways.

Compartments and raceways within the framework of a machine tool may be used to

enclose conductors, provided they are isolated from coolant and oil reservoirs and are entirely enclosed. Conductors in machine compartments and raceways shall be secured and so arranged that they will not be subject to physical damage or abrasion.

E-670.15. Number of Bends in Conduit.

Where a run of rigid metal conduit does not exceed 25 feet in length, and the conductor fill does not exceed 30 per cent of the cross-sectional area of the conduit, the requirements of E-346.11 shall not apply.

C. Conductors

E-670.21. Sizes Permitted.

Circuit and control conductors on or in machines shall not be smaller than No. 14 except as follows:

(1) Conductors to Moving Parts. Copper conductors for control purposes to continuously moving parts may be No. 16 where all such conductors are insulated for the maximum voltage of any conductor in the cable or tubing.

(2) Conductors to Electronic and Precision Devices. Copper conductors to electronic and precision devices may be No. 20, except where pulled into raceways they shall be not smaller than No. 18.

E-670.22. Type.

Conductors shall be of a type suitable for conditions of use. Flexible, non-metallic, multi-conductor cable shall have an oil- and moisture-resistant insulation with a flame-retardant outer covering.

E-670.23. Identification of Conductors.

Conductors shall be identified either by color code or by other distinctive means. White or natural gray coloring shall be used only for a grounded conductor, and green only for a conductor used to ground the frame of equipment.

D. Control Equipment

E-670.31. Mounting.

Controllers shall be mounted in such a manner as to guard against physical damage, oil, coolant, dust, and dirt.

E-670.32. In Machine Compartments.

Compartments in the column or base of a machine may serve as enclosures for control equipment where the following provisions are complied with:

(1) Thickness of Metal. The wall thickness shall be not less than No. 14 MS (USS Revised) gauge when of sheet steel, not less than 1/8-inch when of cast metal, or not less than 3/32-inch where of malleable iron.

(2) Covers. Compartments shall have tight-fitting hinged covers, not thinner than specified in E-670.32(1). Covers shall have adequate means for fastening securely in a closed position.

(3) Control Enclosures. Compartments used for control enclosures shall be readily accessible and shall not contain moving parts not directly connected to electrical control equipment, and shall be so located as to guard the control devices against oil, coolant, chips, and dirt.

(4) Venting. A compartment enclosing group control equipment with branch circuit fusing as specified in E-670.42(2) shall have a clear opening of at least 2 square inches, vented to another compartment within the column or base and having at least one-half the volume of the control compartment.

(5) No Floor Opening. Compartments enclosing control equipment shall not be open to the floor or foundation upon which the machine rests.

E-670.33. Not in Machine Compartment.

Controllers not in machine compartments shall comply with the following:

(1) Controllers with overcurrent protection as permitted by E-670.42 may be mounted on the outside of the machine tool or on the floor as close to the machine tool as possible provided the enclosures comply with all the provisions of E-670.32.

(2) Other controllers may be mounted on the outside of the machine tool or elsewhere when they comply with the provisions of Chapter E-430.

E. Motor Branch-Circuit Overcurrent Protection

E-670.41. Branch Circuits.

Any motor on a machine tool may be supplied from an individual branch circuit

in accordance with the provisions of Chapter E-430, or may be connected to a branch circuit which also supplies other motors on the same machine tool in accordance with the provisions of E-430.053 or of E-670.42. The conductors supplying all motors on a single machine tool may be considered a single branch circuit where all of these motors are protected in accordance with the provisions of E-430.053 or of E-670.42.

E-670.42. Several Motors on One Branch Circuit.

Controllers and running overcurrent protective devices for two or more motors connected to the branch circuit of a single machine tool need not comply with the provisions of E-430.053, where all of the following provisions are complied with:

(1) Motor-Running Protection. Each motor shall be protected by a motor-running overcurrent protective device.

(2) Rating of Overcurrent Devices. The branch circuit shall have overcurrent protection of a rating equal to that specified in E-430.052 for the largest motor connected to the circuit, plus an amount equal to the sum of the full-load current ratings of all other motors on the machine tool which may be in operation at one time under normal conditions of use and which are connected to the same circuit. In no case shall overcurrent protection be more than 200 amperes at 250 volts or less, or 100 amperes at 600 volts or less.

(3) Enclosures. Enclosures for control equipment and running protective devices enclosed in machine compartments, or mounted on or adjacent to the machine, shall comply in all respects with the provisions of E-670.32 or E-670.33.

(4) Conductors. The conductors of the branch circuit shall comply with the provisions of E-430.053(2).

E-670.51. Protection Against Damage.

Where the failure of one motor to operate while others continue to run could cause damage, they shall be so connected that the tripping of any overload or undercurrent device will result in stopping of all of these motors.

E-670.52. Grounding.

All machine tools within the scope of this Chapter, including connected portable equipment, shall be effectively grounded as specified in Chapter E-250.

E-670.53. Moving Parts.

A machine part that moves on grounded metal guides or supporting ways shall be considered as adequately grounded when the movable part may not readily be removed by hand.