

Chapter E 112

PROTECTIVE ARRANGEMENTS OF EQUIPMENT

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E 112.01 General requirement. All electrical equipment shall be of such construction and so installed and maintained as to reduce the life and fire hazard as far as practicable.

History: Cr. Register, November, 1961, No. 71, eff. 12-1-61.

E 112.02 Inspections. (1) **REGULAR EQUIPMENT.** Electrical equipment shall comply with these orders when placed in service and shall thereafter be cleaned when necessary and inspected at such intervals as experience has shown to be necessary. Any equipment or construction known to be defective so as to endanger life or property shall be promptly repaired, permanently disconnected, or isolated until repairs can be made. Repairs, additions and changes to electrical equipment and conductors shall be made by qualified persons only.

(2) **IDLE EQUIPMENT.** Infrequently used equipment or wiring maintained for future service should be thoroughly inspected before use to determine its fitness for service.

(3) **EMERGENCY EQUIPMENT.** Equipment or wiring maintained for emergency service should be periodically inspected and, where necessary, tested to determine its fitness for service.

(4) **NEW EQUIPMENT.** New equipment should be thoroughly inspected before being put in service.

History: Cr. Register, November, 1961, No. 71, eff. 12-1-61.

E 112.03 Guarding shaft ends, pulleys and belts, and suddenly moving parts. (1) **TRANSMISSION MACHINERY.** This code is supplemented by the rules on safety and other Industrial Commission requirements which specify methods for safeguarding pulleys, belts, and other equipment used in the mechanical transmission of power.

(2) **SUDDENLY MOVING PARTS.** Parts of equipment which move suddenly in such a way that persons in the vicinity are liable to be injured by being struck, such as handles and levers of circuit breakers, shall be guarded or isolated.

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E 112.04 Protective grounding. (1) **GROUNDING METHOD.** All grounding which is intended to be a permanent and effective protection measure, such as lightning arrester, circuit, equipment, or wire raceway

grounding, shall be made in accordance with the methods specified in chapters E 103 and E 250.

(2) **GROUNDING, NONCURRENT-CARRYING METAL PARTS.** All electrical equipment, if operating at more than 150 volts to ground, or if in hazardous locations, regardless of voltage, shall have the exposed noncurrent-carrying parts, such as frames of generators and switchboards, cases of transformers, lightning arresters and switches, and operating levers, effectively grounded or isolated. It is recommended that exposed noncurrent-carrying parts of electrical apparatus operating at 150 volts or less to ground be effectively grounded. All metallic guards (including rails, screens, etc.) about electrical equipment should be effectively grounded where such grounding will reduce the hazard.

(a) Except in hazardous locations, exposed noncurrent-carrying parts of equipment operating at more than 150 volts to ground may be left ungrounded and either isolated, or guarded, or provided with insulating mats as required for live parts at the same voltage. Such isolation, guarding, or mats should be so arranged that persons cannot inadvertently touch these parts while also touching a grounded surface.

Note: Hazardous locations include those where dampness, acid fumes, explosives, inflammable gas, or flyings normally exist. (See chapter E 500)

(b) **Exception 1:** Exposed noncurrent-carrying metal parts of equipment of grounded direct-current circuits or series direct-current circuits are exempted from this order, if suitably insulated from the ground and from neighboring grounded surfaces. In addition suitable permanent insulating barrier guards shall be installed so that a person cannot, while touching such insulated frames, at the same time inadvertently touch or stand upon other grounded bodies.

(c) **Exception 2:** Exposed noncurrent-carrying metal parts of supply equipment for communication circuits are exempted from this order, provided they are suitably insulated from the ground and neighboring grounded conductors and surfaces.

(d) **Exception 3:** Metal shell sockets and metal guards of portable lamps, if suitably insulated, are exempted from this order.

(3) **GROUNDING EQUIPMENT DURING REPAIRS.** Electrical equipment or conductors normally operating at more than 750 volts on or about which work is occasionally done while separated from a source of electrical energy by switches or disconnectors only, shall be provided with some means, such as switches, connectors, or readily accessible ground conductor, for grounding them. (See sections E 142.04 and E 142.05)

History: Cr. Register, November, 1961, No. 71, eff. 12-1-61.

E 112.05 Guarding live parts. It is the intent of this rule to require electrical facilities which are or may become alive to be arranged or guarded in such a way as to prevent inadvertent contact by persons or material. The rule requires guards unless the facilities have certain minimum clearances, are isolated by enclosure, or in some cases are arranged in such a way that contact cannot normally be made unless the person is insulated from ground. Station or substation buildings or enclosing walls or fences used to exclude the public or

house the parts are not enclosures within the meaning of this rule (See subsection E 112.05(3)).

(1) WHERE REQUIRED. (a) Ungrounded parts of electrical equipment which operate at or may become charged to more than 150 volts shall be guarded when vertical clearances from ground, floors, platforms, or permanent supports for workmen are less than that given in column 2, table 2, of this rule, or when the horizontal clearance from the nearest edge of such surface is less than that given in column 3 of table 2. This includes parts exposed through windows, wall openings, etc.

1. Exception: Guards need not be provided where it is necessary to permit routine inspection of rotating equipment as required under operating conditions.

Note: The rule applies to the electrical parts energized or considered available for service in temporary or partially completed installations, as well as to permanent installations.

Definitions: The guard zone means the space of minimum clearance from guards to electrical parts where guards may be installed by workmen without definite engineering design. The radius of this zone varies with the voltage as specified in column 4 of table No. 2. (See subsection E 142.03(3) of the code for working clearances about live parts).

Permanent supporting surfaces for workmen include floors, platforms, or structures used regularly and frequently by workmen for inspections and maintenance near live adjacent parts: runways, ladders, stairways, etc.

(b) Parts over or near frequently traveled passageways through which material may be carried, or in or near spaces, such as corridors, storerooms, boiler rooms, etc. used for non-electrical work, should, where practicable, be guarded or given clearances in excess of those specified, such as may be necessary to secure reasonable safety. The guards should be substantial; should, where practicable, completely shield or enclose without openings the parts; and when in spaces used for non-electrical work should be removable only by means of tools or keys.

TABLE NO. 2
MINIMUM CLEARANCE FROM LIVE PARTS

| 1 Voltage | 2 | | 3 | | 4 |
|--------------|---|--------|---|--------|--|
| | Minimum Vertical Clearance of Unguarded Parts | | Minimum Horizontal Clearance of Unguarded Parts | | Minimum Clearance from Guards to Parts, Radius of Guard Zone |
| | Feet | Inches | Feet | Inches | Inches |
| 150..... | 7 | 6 | 3 | 0 | 0.5 |
| 300..... | 7 | 7 | 3 | 1 | 1 |
| 600..... | 7 | 8 | 3 | 2 | 2 |
| 2,300..... | 7 | 9 | 3 | 3 | 3 |
| 6,600..... | 7 | 10 | 3 | 4 | 4 |
| 11,000..... | 9 | 0 | 3 | 6 | 6 |
| 22,000..... | 9 | 3 | 3 | 9 | 9 |
| 33,000..... | 9 | 6 | 4 | 0 | 12 |
| 44,000..... | 9 | 10 | 4 | 4 | 16 |
| 66,000..... | 10 | 5 | 4 | 11 | 23 |
| 88,000..... | 11 | 0 | 5 | 6 | 30 |
| 110,000..... | 11 | 7 | 6 | 1 | 37 |
| 132,000..... | 12 | 2 | 6 | 8 | 44 |

Note: Interpolate for intermediate values.

The clearances in column 4 of this table are not a requirement for definite engineering design of either apparatus or guards, but are solely for the guidance of workmen installing guards without such design.

For example, the minimum clearances in the table above are not intended to refer to the clearances between live parts and the walls of cells, compartments, or similar enclosing structures. They do not apply to the clearances between bus bars and supporting structures, nor to clearances between the blade of a disconnecting switch and its base.

(c) Parts of indeterminate potential, such as telephone wires exposed to induction from high-tension lines, ungrounded neutral connections, ungrounded frames, ungrounded parts of lightning arresters, ungrounded instrument cases connected directly to the high-voltage circuit, etc., shall be classified and, where practicable, guarded on the basis of the maximum voltage which may be present.

(2) **STRENGTH OF GUARDS.** Guards shall be sufficiently strong and shall be supported rigidly and securely enough to prevent them from being displaced or dangerously deflected by a man slipping or falling against them.

(3) **TYPES OF GUARDS.** (a) *Location or isolation.* Parts having clearances equal to or greater than specified in subsection E 112.05 (1) above are guarded by location. Parts are guarded by isolation when all entrances to enclosed spaces, runways, ladders, etc. are kept locked or warning signs posted at all entrances, in which case no other permanent guards need be supplied. The enclosures referred to are those within stations, substations or vaults which contain limited amounts of equipment that must be entered for work of a very limited nature. For example, the area in back of an open back switchboard may be enclosed to eliminate the necessity of guards but enclosing an outdoor substation in a fence does not eliminate the necessity of guards.

(b) *Grounded metal cable sheaths.* These are suitable guards except where exposed to mechanical injury. Where so exposed, metal conduit or other suitable guards should be provided.

(c) *Railings and fences.* Railings are not substitutes for complete guards, and if used shall be located at a horizontal distance of at least 3 feet (and preferably not more than 4 feet) from the nearest point of guard zone, which is less than $7\frac{1}{2}$ feet above the floor. Fences used to exclude the public from electrical equipment, shall be so placed that they are not closer to live parts or parts that may become alive than that given in column 3 of table 2, subsection E 112.05(1). Such fences shall be of a type that cannot be readily climbed and be not less than 5 feet in height when enclosing equipment operating at 15,000 volts or less and not less than 6 feet in height where the voltage is above 15,000.

(d) *Location of guards.* Guards inside of the guard zone or less than 4 inches outside, shall completely enclose the parts from contact up to the heights listed in column 2 of table No. 2 of subsection E 112.05(1). They shall not be closer to the live parts than listed in column 4 of the table in subsection E 112.05(1) except when suitable insulating material is used with circuits of less than 7,500 volts. (See note under table in subsection E 112.05(1)). If more than 4 inches outside of the guard zone, the guards need not extend more than $7\frac{1}{2}$ feet above the floor. Covers or guards, which must at any time be removed while the parts they guard are alive, should be arranged so that they cannot readily be brought in contact with live parts. This does not apply to enclosing fences as described in subsection (c) above and subsection E 111.01(4).

(e) *Insulating covering on conductors or parts.* The insulating covering on parts exceeding 750 volts shall not be considered a protection. For parts less than 750 volts, positive barriers, enclosures, or similar arrangements are preferable, but in dry places where not ex-

posed to mechanical injury, varnished-cloth tape, or other insulation suitable for the voltage involved may be used, as a guard. The taping over connections shall be of a type and thickness suitable for the voltage involved. Friction tape is not acceptable as the sole protection.

1. Exception: On circuits not exceeding 7500 volts, when other guarding is impracticable, insulation suitable for the voltage involved may be used back of the switchboards or in equivalent sheltered locations. Insulating mats or platforms shall be provided so that an operator cannot readily touch the insulating covering without standing on the mats.

(f) *Mats.* Suitable insulating mats placed so that a person cannot inadvertently come in contact with the live parts without standing on the mat may be used in the following cases:

1. Parts less than 750 volts, exposed at switchboards, switches, or on rotating machinery.

2. Disconnect switches less than 7,500 volts mounted on back of switchboards or in similar sheltered locations when barriers are placed between each blade so as to extend beyond the disconnected parts in any position. Other means of guarding may be used where convenient.

3. Ungrounded frames of existing high-voltage series generators.

4. As provided for in subsections E 112.05 (3) (e) and (3) (h).

5. Mats should be of rubber or other suitable insulating material, or in dry locations they may be of wood fastened with wood pins, cork matting, or heavy (one-fourth inch) linoleum laid without joints and without metal fastenings. A "nonslip" surface should be maintained and the mats should be laid and maintained so as to reduce the tripping hazard to a minimum.

Note: Beveled edges will help in many cases.

(g) *Parts below supporting surfaces for persons.* The supporting surfaces above live parts shall be without openings. Toe boards at least 6 inches high shall be provided at all edges.

(h) *Special rules for plug-type switchboards.* A mat is a suitable guard when placed so that the operator must stand on it when operating the plugs. Suitable guards on handles of all plugs shall be provided.

(4) PARTS OF LESS THAN 300 VOLTS. It is recommended that live parts of more than 150 volts be enclosed or guarded when in exposed locations.

History: Cr. Register, November, 1961, No. 71, eff. 12-1-61.

E 112.06 Working space about electrical equipment. (1) WHERE REQUIRED. Adequate and readily accessible working space with secure footing shall be maintained about all electrical parts or equipment which require adjustment or examination if exposed while in service.

(2) WIDTH OF WORKING SPACE. The horizontal clearance from the farthest edge of the working space to the nearest live part of more than 300 volts, exposed after removing guards, shall be not less than 3 feet plus the guard zone radius as given in column 4 of the table in section E 112.05. (When the live parts are on only one side, column 3 of the table in section E 112.05 gives the minimum permissible value for the total width of the free space). See also subsection E 111.03(6) for headroom.

(3) **ELEVATED PARTS.** Clearance about normally elevated or isolated parts requiring occasional adjustment should be provided so the men need not come within the danger zone (See subsection E 142.02(3) of this code) around adjacent energized parts, unless guarded in accordance with sections E 112.05 and E 112.06.

History: Cr. Register, November, 1961, No. 71, eff. 12-1-61.

E 112.07 Equipment for work on live parts. (1) **7,500 VOLTS OR LESS.** When it is necessary for men to bring their bodies or any material or tools handled into the danger zone (see subsection E 142.03(2) of this code) suitable protective devices, such as rubber gloves, rubber sleeves (if necessary), insulating tools, portable rubber mats or insulating stools, rubber blankets, insulated fuse pullers, testing and grounding devices, switch sticks, etc., should be provided, periodically examined, and kept in safe condition. If the voltage exceeds the limit of 5,000 volts set for standard rubber gloves, special gloves should be furnished if the work is conducted so that their use is necessary.

(2) **MORE THAN 7,500 VOLTS.** Suitable protective devices, such as testing and grounding devices, switch sticks, fuse pullers, special insulated tools, etc., should be provided, periodically inspected, and kept in safe condition. Such devices shall provide an ample margin of safety for the voltage involved and should be constructed so that the workman's body can remain outside of the danger zone. (See subsection E 142.03(3) of this code).

History: Cr. Register, November, 1961, No. 71, eff. 12-1-61.

E 112.08 Hazardous locations. (1) **ENCLOSURE OF ARCING AND HEATING PARTS.** In locations where flammable gas or flammable flyings normally exist in dangerous quantities, all parts where sparking, arcing, or dangerous heating is liable to occur shall be enclosed so as to reduce the hazards as far as practicable. This enclosure shall be by one of the following methods:

- (a) By placing in separate compartments or rooms.
- (b) By using nonabsorptive, noncombustible casings of the dust-tight type when flammable dust or flyings are present.
- (c) By using nonabsorptive, noncombustible casings designed for use in explosive atmospheres when flammable gas exists in dangerous quantities.

(2) **GROUNDING.** The metal frames and other exposed noncurrent-carrying metal parts of equipment in these locations shall be effectively grounded as specified in chapter 103.

The flammable liquids code published by the Industrial Commission should be consulted.

History: Cr. Register, November, 1961, No. 71, eff. 12-1-61.

E 112.09 Shielding of equipment from deteriorating agencies. Suitable shields or enclosures shall be provided to protect exposed current-carrying parts, insulation of leads of electrical devices or equipment where susceptible to injury by being installed directly under rotating equipment or in other locations where dripping oil, excessive moisture, steam, vapors, or similar agents exist. (For battery rooms see section E 114.07).

History: Cr. Register, November, 1961, No. 71, eff. 12-1-61.

E 112.10 Identification. (1) **EQUIPMENT IN GENERAL.** Electrical equipment shall be suitably identified when necessary for safety. The identification may be by position, color, number, name-plate, label, design, or other means, but the method of identification chosen shall be uniform throughout any one system. (See section E 117.05 for switches). The voltage and intended use shall be shown when important. Identification marks should not, if possible, be placed on removable covers or casings, such as instrument covers and disconnect compartment doors, where the interchanging of these removable parts might lead to accident.

(2) **GENERATORS AND MOTORS.** Generators and motors shall each be provided with a name-plate giving the maker's name, the rating, normal full-load speed and the voltage.

History: Cr. Register, November, 1961, No. 71, eff. 12-1-61.