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§2320.3 Tests.

All electrical equipment and systems shall be treated as energized as required by Section 2320.2 until tested or otherwise proven to be de-energized.

§2320.4 De-Energized Equipment or Systems.

(a) **An authorized person shall be responsible** for the following before working on de-energized electrical equipment or systems unless the equipment is physically removed from the wiring system:

- (1) *Notifying all involved personnel.*
- (2) *Locking the disconnecting means in the "open" position with the use of lockable devices, such as padlocks, combination locks or disconnecting of the conductor(s) or other positive methods or procedures which will effectively prevent unexpected or inadvertent energizing of a designated circuit, equipment or appliance.*

Note: See also Section 3314 of the General Industry Safety Orders (GISO) for lock-out requirements pertaining to the cleaning, repairing, servicing and adjusting of prime movers, machinery and equipment.

Exception: Locking is not required under the following conditions:

- (A) Where tagging procedures are used as specified in subsection (a)(3), and
 - (B) Where the disconnecting means is accessible only to personnel instructed in these tagging procedures.
- (3) *Tagging the disconnecting means with suitable accident prevention tags conforming to the provisions of Section 2320.6 and GISO Section 3314(e).*
 - (4) *Effectively blocking the operation or dissipating the energy of all stored energy devices which present a hazard, such as capacitors or pneumatic, spring-loaded and like mechanisms.*

§2320.5 Energizing (or Re-Energizing) Equipment or Systems.

(a) **An authorized person shall be responsible** for the following before energizing equipment or systems which have been de-energized:

- (1) *Determining that all persons are clear from hazards which might result from the equipment or systems being energized.*
- (2) *Removing locking devices and tags.*
 - (A) *Locking devices and tags may be removed only by the employee who placed them. Locking devices and tags shall be removed upon completion of the work and after the installation of the protective guards and/or safety interlock systems.*

Exception: When the employee has left the premises or is otherwise unavailable, other persons may be authorized by the employer to remove the locking devices and tags in accordance with a procedure determined by the employer.

§2320.6 Accident Prevention Tags.

(a) **Suitable accident prevention tags shall be used** to control a specific hazard. Such tags shall provide the following minimum information:

- (1) *Reason for placing tag.*
- (2) *Name of person placing the tag and how that person may be contacted.*
- (3) *Date tag was placed.*

§2320.7 Safety Precautions.

- (a) **Suitable temporary barriers, or barricades,** shall be installed when access to opened enclosures containing exposed energized electrical equipment is not under the control of an authorized person.
- (b) **Conductive measuring tapes, ropes** or similar measuring devices shall not be used when working on or near exposed energized conductors or parts of equipment.
- (c) **Conductive fish tapes shall not be used** in raceways entering enclosures containing exposed energized parts unless such parts are isolated by suitable barriers.
- (d) **Prior to climbing poles or other elevated structures** supporting overhead electrical lines or equipment, an inspection shall be made to assure that such poles or structures are in safe condition for the work to be performed. Where poles or structures are determined to be unsafe for climbing, they shall not be climbed until made safe by guying, bracing or other adequate means.

§2320.8 Fall Protection.

(a) **Fall Protection.** When work is performed at elevated locations more than 4 feet (1.2 meters) above the ground on poles, towers or similar structures, the employer shall require the employees to use either fall arrest equipment, work positioning equipment, or travel restricting equipment, if other fall protection methods have not been provided (e.g., guardrails, safety nets, etc.). The use of body belts for fall arrest systems is prohibited.

Exception: Point to point travel by a qualified person, unless conditions such as ice, high winds, design of the structure, or other condition (e.g., chemical contaminants) prevents the employee from gaining a firm hand or foothold while traveling.

§2320.9 Backfeeding or Interconnection.

No electrical power source, permanent or temporary, shall be connected to a premises wiring system, or parts of such a system, unless positive means are used to prevent the transmission of electricity beyond the premises wiring system, or beyond any intentionally segregated parts of such system.

Exception: When an interconnection has been authorized by the servicing utility.

Article 4**Requirements for Electrical Installations****GENERAL****§2340.1 Maintenance.**

Electrical equipment shall be maintained free from recognized hazards that are likely to cause death or serious physical harm to employees.

§2340.2 Examination, Installation, and Use of Equipment.

(a) **Examination.** Electric equipment shall be free from recognized hazards that are likely to cause death or serious physical harm to employees. Safety of equipment shall be determined using the following considerations:

- (1) *Suitability for installation and use in conformity with the provisions of these Orders;*

Note to subsection (a)(1): Suitability of equipment for an identified purpose may be evidenced by listing or labeling for that identified purpose.

- (2) *Mechanical strength and durability,* including, for parts designed to enclose and protect other equipment, the adequacy of the protection thus provided;
- (3) *Wire-bending and connection space;*
- (4) *Electrical insulation;*
- (5) *Heating effects under all conditions of use;*
- (6) *Arcing effects;*
- (7) *Classification by type, size, voltage, current capacity, and specific use; and*
- (8) *Other factors that contribute to the practical safeguarding of persons using or likely to come in contact with the equipment.*

(b) **Installation and use.** Listed or labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling.

§2340.5 Conductors.

- (a) **Insulation.** All conductors used for general wiring shall be insulated unless otherwise permitted in these safety orders.
- (b) **Type.** The conductor insulation shall be of a type that is approved for the voltage, operating temperature, and location of use.
- (c) **Distinguishable.** Insulated conductors shall be distinguishable by appropriate color or other suitable means as being grounded conductors, ungrounded conductors, or equipment grounding conductors.

§2340.8 Insulation Integrity.

Completed wiring installations shall be free from short circuits and from grounds other than those required or permitted by these Safety Orders.

§2340.9 Interrupting Rating.

- (a) **Equipment intended to interrupt current** at fault levels shall have an interrupting rating sufficient for the nominal circuit voltage and the current which is available at the line terminals of the equipment.
- (b) **Equipment intended to interrupt current** at other than fault levels shall have an interrupting rating at nominal circuit voltage sufficient for the current that must be interrupted.

§2340.10 Circuit Impedance and Other Characteristics.

The overcurrent protective devices, the total impedance, the component short-circuit current ratings, and other characteristics of the circuit to be protected shall be selected and coordinated to permit the circuit protective devices used to clear a fault to do so without the occurrence of extensive damage to the electrical components of the circuit. This fault shall be assumed to be either between two or more of the circuit conductors, or between any circuit conductor and the grounding conductor or enclosing metal raceway.

§2340.11 Deteriorating Agents.

(a) **Unless approved for the purpose,** no conductors or equipment shall be located:

- (1) *In damp or wet locations.*
- (2) *Where exposed to gases, fumes, vapors, liquids, or other agents that have a deteriorating effect on the conductors or equipment.*
- (3) *Where exposed to excessive temperatures.*

§2340.12 Mechanical Execution of Work.

- Electric equipment shall be installed in a neat and workmanlike manner.
- (a) **Unused openings in boxes, raceways,** auxiliary gutters, cabinets, equipment cases, or housings shall be effectively closed to afford protection substantially equivalent to the wall of the equipment.
 - (b) **Conductors shall be racked to provide** ready and safe access in underground and subsurface enclosures that persons enter for installation and maintenance.
 - (c) **Internal parts of electrical equipment,** including busbars, wiring terminals, insulators, and other surfaces, shall not be damaged or contaminated by foreign materials such as paint, plaster, cleaners, abrasives, or corrosive residues.
 - (d) **There shall be no damaged parts** that may adversely affect safe operation or mechanical strength of the equipment, such as parts that are broken, bent, cut, or deteriorated by corrosion, chemical action, or overheating.

§2340.13 Mounting and Cooling of Equipment.

- (a) **Mounting.** Electric equipment shall be firmly secured to the surface on which it is mounted.
Note: Wooden plugs driven into holes in masonry, concrete, plaster, or similar materials are not considered secure means of fastening electric equipment
- (b) **Electric equipment that depends on the natural circulation** of air and convection principles for cooling of exposed surfaces shall be installed so that room airflow over such surfaces is not prevented by walls or by adjacent installed equipment. For equipment designed for floor mounting, clearance between top surfaces and adjacent surfaces shall be provided to dissipate rising warm air.
- (c) **Cooling.** Electrical equipment provided with ventilating openings shall be installed and maintained so that free circulation of air through the equipment is not obstructed.

§2340.14 Electrical Connections.

- (a) **General.** Because of different characteristics of dissimilar metals:
 - (1) **Devices such as pressure terminal or pressure splicing connectors** and soldering lugs shall be identified for the material of the conductor and shall be properly installed and used;
 - (2) **Conductors of dissimilar metals may not be intermixed** in a terminal or splicing connector where physical contact occurs between dissimilar conductors (such as copper and aluminum, copper and copper-clad aluminum, or aluminum and copper-clad aluminum) unless the device is identified for the purpose and conditions of use; and
 - (3) **Materials such as solder, fluxes, inhibitors,** and compounds, where employed, shall be suitable for the use and shall be of a type that will not adversely affect the conductors, installation, or equipment.
- (b) **Terminals.**
 - (1) **Connection of conductors to terminal parts** shall ensure a good connection without damaging the conductors and shall be made by means of pressure connectors (including set-screw type), solder lugs, or splices to flexible leads. However, No. 10 or smaller conductors may be connected by means of wire binding screws or studs and nuts having upturned lugs or equivalent.
 - (2) **Terminals for more than one conductor** and terminals used to connect aluminum shall be so identified.
- (c) **Splices.**
 - (1) **Conductors shall be spliced or joined** with splicing devices identified for the use or by brazing, welding, or soldering with a fusible metal or alloy. Soldered splices shall first be spliced or joined to be mechanically and electrically secure without solder and then soldered. All splices and joints and the free ends of conductors shall be covered with an insulation equivalent to that of the conductors or with an insulating device identified for the purpose.
 - (2) **Wire connectors or splicing means** installed on conductors for direct burial shall be listed for such use.

§2340.16 Work Space About Electric Equipment.

- (a) **Space about electric equipment.** Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.
- (b) **Work Space.** Working space for equipment likely to require examination, adjustment, servicing, or maintenance while energized shall comply with the following dimensions, except as required or permitted elsewhere in these Orders.
 - (1) **Depth.** The depth of the working space in the direction of access to live parts shall not be less than indicated in Table 2340.16 unless permitted elsewhere in these orders.

Distances shall be measured from the live parts if they are exposed or from the enclosure front or opening if they are enclosed.

- (2) **Width.** In addition to the dimensions of depth shown in Table 2340.16, the width of the workspace in front of the electric equipment shall not be less than the width of the equipment or 30 inches, whichever is greater. In all cases, the workspace shall be adequate to permit at least a 90 degree opening of equipment doors or hinged panels.
- (3) **Height.** The work space shall be clear and extend from the grade, floor, or platform to the height required by subsection (f) of this section. However, other equipment associated with the electrical installation and located above or below the electric equipment may extend not more than 6 in. (153 mm) beyond the front of the electric equipment.

Table 2340.16 Minimum Depth of Clear Working Space at Electric Equipment, 600 V or Less

Nominal Voltage to Ground	Minimum Clear Distance					
	Condition 1		Condition 2		Condition 3	
	Feet	Meters	Feet	Meters	Feet	Meters
0-150	3*	0.9	3*	0.9	3	0.9
151-600	3*	0.9	3.5	1.0	4	1.2

Notes to Table 2340.16:
 Where the "Conditions" are as follows:
Condition 1 — Exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on both sides effectively guarded by suitable wood or other insulating materials. Insulated wire or insulated busbars operating at 300 volts or less shall not be considered live parts.
Condition 2 — Exposed live parts on one side and grounded parts on the other side. Concrete, brick, or tile surfaces shall be considered as grounded surfaces.
Condition 3 — Exposed live parts on both sides of the workspace (not guarded as provided in Condition (1)) with the operator between.

Exceptions:
 *1. Minimum clear distances may be 2.5 ft. (0.7 m) for installations built before April 16, 1981.
 2. Working space is not required in back of assemblies such as dead-front switchboards or motor control centers where there are no renewable or adjustable parts (such as fuses or switches) on the back and where all connections are accessible from locations other than the back.
 3. Where rear access is required to work on deenergized parts on the back of enclosed equipment, a minimum working space of 30 in. (762 mm) horizontally shall be provided.

- (c) **Clear Spaces.** Working space required by this section shall not be used for storage. When normally enclosed live parts are exposed for inspection or servicing, the working space, if in a passageway or general open space, shall be suitably guarded.
- (d) **Entrance and Access to Workspace.** At least one entrance of sufficient area shall be provided to give access to the working space about electric equipment.
 - (1) **For equipment rated 1,200 amperes or more** and over 6 feet (1.83 m) wide, containing overcurrent devices, switching devices, or control devices, there shall be one entrance not less than 24 inches (610 mm) wide and 6 feet 6 inches (1.98 m) high at each end of the workspace, except that:
 - (A) **Where the location permits a continuous** and unobstructed way of exit travel, one means of exit is permitted; or
 - (B) **Where the working space required by subsection (b)** of this section is doubled, only one entrance to the working space is required; however, the entrance shall be located so that the edge of the entrance nearest the equipment is the minimum clear distance given in Table 2340.16 away from such equipment.
 - (2) **Attics, furrowed ceilings and underfloor spaces** shall have minimum unobstructed access openings of 22 inches by 30 inches.
- (e) **Illumination.** Portable or fixed illumination, suitable for the nature of the work being performed, shall be provided when working on electrical equipment. The light fixtures and their control points shall be so arranged that persons operating light switches, replacing lamps or making repairs on the lighting system will not be endangered by energized parts of other equipment.
Exception: Additional lighting fixtures are not required where the working space is illuminated by an adjacent light source. In electric equipment rooms, the illumination may not be controlled by automatic means only.
- (f) **Headroom.** The minimum headroom of working space about service equipment, switchboards, panelboards and motor controllers control centers, which require manual operation or where there are energized parts exposed at any time, shall be as follows:
 - (1) **For installations built before May 5, 2008** 6 feet 3 inches (1.91 m).
 - (2) **For installations built on or after May 5, 2008** 6 feet 6 inches (1.98 m), except that where the electrical equipment exceeds 6.5 feet (1.98 m) in height, the minimum headroom may not be less than the height of the equipment.

(g) For installations built on or after May 5, 2008, switchboards, panelboards, and distribution boards installed for the control of light and power circuits, and motor control centers shall be located in dedicated spaces and protected from damage.

(1) **Indoor.** For indoor installation, the dedicated space shall comply with the following:

(A) *The space equal to the width and depth of the equipment* and extending from the floor to a height of 6.0 feet (1.83 m) above the equipment or to the structural ceiling, whichever is lower, shall be dedicated to the electrical installation. Unless isolated from equipment by height or physical enclosures or covers that will afford adequate mechanical protection from vehicular traffic or accidental contact by unauthorized personnel or that complies with subsection (g)(1)(B) of this section, piping, ducts, or equipment foreign to the electrical installation shall not be located in this area;

(B) *The space equal to the width and depth of the equipment* shall be kept clear of foreign systems unless protection is provided to avoid damage from condensation, leaks, or breaks in such foreign systems. This area shall extend from the top of the electric equipment to the structural ceiling;

(C) *Sprinkler protection is permitted* for the dedicated space where the piping complies with this section; and

(D) *Control equipment that by its very nature* or because of other requirements in these Orders must be adjacent to or within sight of its operating machinery is permitted in the dedicated space.

Note to subsection (g)(1): A dropped, suspended, or similar ceiling that does not add strength to the building structure shall not be considered a structural ceiling.

(2) **Outdoor.** Outdoor electric equipment shall be installed in suitable enclosures and shall be protected from accidental contact by unauthorized personnel, or by vehicular traffic, or by accidental spillage or leakage from piping systems. No architectural appurtenance or other equipment may be located in the working space required by subsection (b) of this section.

§2340.17 Guarding of Energized Parts.

(a) **Except as elsewhere required or permitted** by these orders, energized parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact by use of approved cabinets or other forms of approved enclosures or by any of the following means:

(1) *By location in a room, vault, or similar enclosure* that is accessible only to qualified persons.

(2) *By suitable permanent, substantial partitions* or screens so arranged that only qualified persons will have access to the space within reach of the energized parts. Any openings in such partitions or screens shall be so sized and located that persons are not likely to come into accidental contact with the energized parts or to bring conducting objects into contact with them.

(3) *By location on a suitable balcony, gallery, or platform* so elevated and otherwise located as to prevent access by unqualified persons; or

(4) *By elevation of 8.0 feet (2.44 m) or more* above the floor or other working surface.

(b) **In locations where electric equipment is likely** to be exposed to physical damage, enclosures or guards shall be so arranged and of such strength as to prevent such damage.

(c) **Entrances to rooms and other guarded locations** containing exposed live parts shall be marked with conspicuous warning signs forbidding unqualified persons to enter.

§2340.18 Arcing Parts.

Parts of electric equipment which in ordinary operation produce arcs, sparks, flames, or molten metal shall be enclosed or separated and isolated from all combustible material.

§2340.21 Marking.

(a) **Identification of Manufacturer and Ratings.** Electric equipment shall not be used unless the following markings have been placed on the equipment:

(1) *The manufacturer's name, trademark,* or other descriptive marking by which the organization responsible for the product may be identified; and

(2) *Other markings giving voltage, current, wattage, or other ratings.*

(b) **Durability.** The marking shall be of sufficient durability to withstand the environment involved.

§2340.22 Identification of Equipment.

(a) **Motors and Appliances.** Each disconnecting means required by this Safety Order for motors and appliances shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident.

(b) **Services, Feeders, and Branch Circuits.** Each service, feeder, and branch circuit, at its disconnecting means or overcurrent device, shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident.

(c) **Each service disconnecting means** shall plainly indicate whether it is in the open or closed position.

(d) **Durability of Markings.** The markings shall be of sufficient durability to withstand the environment involved.

(e) **Capable of Accepting a Lock.** Effective with installations made after May 5, 2008 disconnecting means required by these Orders shall be capable of being locked in the open position.

(f) **Marking for Series Combination Ratings.** Effective with installations made after May 5, 2008:

(1) *Where circuit breakers or fuses are applied* in compliance with the series combination ratings marked on the equipment by the manufacturer, the equipment enclosures shall be legibly marked in the field to indicate that the equipment has been applied with a series combination rating.

(2) *The marking required by subsection (e)(1) of this section* shall be readily visible and shall state

CAUTION

SERIES COMBINATION SYSTEM RATED—AMPERES.

IDENTIFIED REPLACEMENT COMPONENT REQUIRED.

§2340.24 Discontinued Circuits.

When a circuit is abandoned or discontinued, its conductors shall be removed from the raceways, or be maintained as if in use.

§2340.26 Mechanical Protection.

In locations where electric equipment would be exposed to physical damage, enclosures or guards shall be so arranged and of such strength as to prevent such damage.

§2340.27 Location of Control and Protective Devices.

All switches, circuit breakers, fuses and other control and protective devices shall be so located or arranged that they may be safely operated, removed or repaired.

Article 5

Use and Identification of Grounded Conductors

§2350.2 General.

(a) **Identification of Conductors.**

(1) *A conductor used as a grounded conductor* shall be identifiable and distinguishable from all other conductors.

(2) *A conductor used as an equipment grounding conductor* shall be identifiable and distinguishable from all other conductors.

(b) **Polarity of Connections.** No grounded or grounding conductor shall be attached to any terminal or lead so as to reverse designated polarity.

(c) **Use of Grounding Terminals and Devices.** A grounding terminal or grounding-type device on a receptacle, cord connector, or attachment plug shall not be used for purposes other than grounding.

Article 6

Branch Circuits

§2360.1 Identification of Multiwire Branch Circuits.

For installations built on or after May 5, 2008 where more than one nominal voltage system exists in a building containing multiwire branch circuits, each ungrounded conductor of a multiwire branch circuit, where accessible, shall be identified by phase and system. The means of identification shall be permanently posted at each branch-circuit panelboard.