TITLE 8, DIVISION 1, CHAPTER 4

Electrical Safety Orders
Group 1. Low-Voltage Electrical Safety Orders
Article 1. Definitions

Amend Section 2300 to add the following definitions within the existing definitions in alphabetical order:

§2300. Definitions.

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Bare Conductor. See Conductor.
Barricade. Physical obstruction such as tapes, screens, cones, or structures that are setup in a manner intended to warn and limit access to a hazardous area.
Barrier. [No change to text.]

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Cabinet. [No change to text.]
Cable Sheath. A protective covering applied to cables.
Cable Tray System. [No change to text.]

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Certified. [No change to text.]
Circuit. A conductor or system of conductors through which an electric current is intended to flow.
Circuit Breaker. [No change to text.]
Competent Supervision. Direction of a work activity by a person fully knowledgeable of and trained in the hazards inherent in the work, with authority to control the actions of those being supervised.
Concealed. [No change to text.]

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Covered Conductor. (See under "Conductor.")
Current-Carrying Part. A conductor connected in an electric circuit to a source of voltage.
Cutout Box. [No change to text.]

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Mineral-Insulated Metal-Sheathed Cable (Type MI). [No change to text.]
<u>Minimum Approach Distance. The closest distance a qualified person, which includes qualified electrical worker, qualified tree worker, and qualified line clearance tree trimmer may approach an energized or a grounded object.</u>
Mobile X-Ray. [No change to text.]

*****

Pull Box. [No change to text.]
<u>Qualified Electrical Worker. A qualified person who by reason of a minimum of two years of training and experience with high-voltage circuits and equipment and who has demonstrated by performance familiarity with the work to be performed and the hazards involved.</u>
<u>Qualified Line Clearance Tree Trimmer. A person who has completed a minimum of 18 months-related training and on-the-job experience and is familiar with the special techniques and hazards involved in line clearance tree trimming operations.</u>
Qualified Person. [No change to text.]
<u>Qualified Tree Worker. An employee who, through related training and on-the-job experience, has demonstrated familiarity with the techniques and hazards of tree maintenance, removal, and the equipment used in the specific operations involved.</u>
Raceway. [No change to text.]

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NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 1. Low-Voltage Electrical Safety Orders
Article 3. Work Procedures

Amend Section 2320.2 to read:

§2320.2. Energized Equipment or Systems.

(a) Work shall not be performed on exposed energized parts of equipment or systems until the following conditions are met:

(1) ~~Responsible~~ <u>Competent</u> supervision has determined that the work is to be performed while the equipment or systems are energized.

(2) Involved personnel have received instructions on the work techniques and hazards involved in working on energized equipment.

(3) Suitable personal protective equipment and safeguards (i.e., approved insulated gloves or insulated tools) are provided and used.

EXCEPTION: The use of approved insulating gloves or insulated tools or other protective measures are not required when working on exposed parts of equipment or systems energized at less than 50 volts provided a conclusive determination has been made prior to the start of work by a qualified person that there will be no employee exposure to electrical shock, electrical burns, explosion or hazards due to electric arcs.

(A) Rubber insulating gloves shall meet the provisions of the American Society for Testing Materials (ASTM) ~~D 120-02a~~ <u>D120-09</u>, Standard Specification for Rubber Insulating Gloves, and be maintained in accordance with ASTM ~~F 496-02a~~ <u>F496-08</u>, Standard Specification for In-Service Care of Insulating Gloves and Sleeves, which are hereby incorporated by reference.
NOTE: The ASTM F ~~496-02a~~ <u>F496-08</u> standard contains provisions regarding the care, inspection, testing and use of insulating gloves and sleeves. Among other requirements, this standard provides that electrical retests shall not exceed 6 months for insulating gloves and 12 months for insulating sleeves and that insulating gloves and sleeves that have been electrically tested but not issued for service shall not be placed into service unless they have been electrically tested within the previous twelve months.

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(8) Each employee who is exposed to the hazards of flames or electric arcs wears apparel that, when exposed to flames or electric arcs, does not increase the extent of injury that would be sustained by the employee. This subsection prohibits clothing made from the following types of fabrics, either alone or in blends, unless the employee can demonstrate that the fabric has been treated with flame retardant: acetate, nylon, polyester, and rayon.

NOTE to subsection (a)(8): See Section 2320.11 for protection from flames and electric arcs that apply to power generation, transmission and distribution.

(b) Making Connections. The employer shall ensure that employees make connections as follows:

(1) In connecting deenergized equipment or lines to an energized circuit by means of a conducting wire or device, an employee shall first attach the wire to the deenergized part;

(2) When disconnecting equipment or lines from an energized circuit by means of a conducting wire or device, an employee shall remove the source end first; and

(3) When lines or equipment are connected to or disconnected from energized circuits, an employee shall keep loose conductors away from exposed energized parts.

EXCEPTION to subsection (b). If conducting wire(s) or device(s) is/are secured by mechanical means to prevent accidental movement of conducting wires, the employer can determine the order of connection.

~~(b)~~(c) After the required work on an energized system or equipment has been completed, an authorized person shall be responsible for:

(1) Removing from the work area any temporary personnel protective equipment, and

(2) Reinstalling all permanent barriers or covers.

(d) Minimum Approach Distance. The employer shall ensure that no employee takes a conductive object closer to energized parts than the established minimum approach distances unless:

Minimum Approach Distances		
Voltage (V)	Phase to Ground	Phase to Phase
0-300	Avoid contact	Avoid contact
301-600	1 foot 1 inch	1 foot 1 inch

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NOTE: For voltages greater than 600 Volts, see Section 2940.2.

(1) The qualified employee is insulated or guarded from the energized part (rubber insulating gloves or gloves with sleeves rated for the voltage involved shall be considered insulation of the employee from the energized part upon which the qualified employee is working provided that the qualified employee has control of the part in a manner sufficient to prevent exposure to uninsulated portions of the employee's body), or

(2) The energized part is insulated or guarded from the employee and any other conductive object at a different potential.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
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Article 3. Work Procedures

Amend Section 2320.7 to read:

§2320.7. Safety Precautions.

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(d) Conductive Articles. When an employee performs work within reaching distance of exposed energized parts of equipment, the employer shall ensure that the employee removes all exposed conductive articles, such as keychains or watch chains, rings, or wrist watches or bands, unless such articles do not increase the hazards associated with contact with the energized parts.

~~(d)~~(e) 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.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 1. Low-Voltage Electrical Safety Orders
Article 3. Work Procedures

Amend Section 2320.8 to read:

§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.~~

(1) Climbing or changing location. Qualified employees climbing or changing locations on poles, towers, or similar structures shall use fall protection equipment.

EXCEPTION to subsection (a)(1): The employer can demonstrate that fall protection is infeasible or creates a greater hazard.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Order
Group 1. Low-Voltage Electrical Safety Orders
Article 3. Work Procedures

Add new Section 2320.11 to read:

§2320.11. Protection From Flames and Electric Arcs.

Scope: This section covers the construction, operation, and maintenance of electric power generation, control, transformation, transmission, and distribution lines and equipment. This includes related equipment for the purpose of communication or metering that are accessible only to qualified employees.

(a) Hazard Assessment.

(1) The employer shall assess the workplace in accordance with GISO, Section 3203 to identify employees exposed to hazards from flames or from electric arcs.

(2) For each employee exposed to hazards from electric arcs, the employer shall make a reasonable estimate of the incident heat energy to which the employee would be exposed.

NOTE 1 to subsection (a)(2): Appendix D of the HVESO provides guidance on estimating available heat energy. The Division of Occupational Safety and Health will deem employers following the guidance in Appendix D to this article to be in compliance with subsection (a)(2) of this section. An employer may choose a method of calculating incident heat energy not included in Appendix D to this article if the chosen method reasonably predicts the incident energy to which the employee would be exposed.

NOTE 2 to subsection (a)(2): This subsection does not require the employer to estimate the incident heat energy exposure for every job task performed by each employee. The employer may make broad estimates that cover multiple system areas provided the employer uses reasonable assumptions about the energy-exposure distribution throughout the system and provided the estimates represent the maximum employee exposure for those areas. For example, the employer could estimate the heat energy just outside a substation feeding a radial distribution system and use that estimate for all jobs performed on that radial system.

(b) Selection and Prohibited Clothing. The employer shall select the apparel based on the hazard assessment in subsection (a)(2) and shall ensure that each employee who is exposed to hazards from flames or electric arcs is provided suitable apparel in accordance with the requirements of

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Section 2940.6(k). The employer shall not select the apparel that could melt onto his or her skin or that could ignite and continue to burn when exposed to flames or the heat energy estimated under subsection (a)(2) of this section.

(1) Flame-resistant clothing. The employer shall ensure that the outer layer of clothing worn by an employee, except for clothing not required to be arc rated under subsections (b)(2)(A-E) of this section, is flame resistant under any of the following conditions:

(A) An electric arc could ignite flammable material in the work area that, in turn, could ignite the employee's clothing,

(B) Molten metal or electric arcs from faulted conductors in the work area could ignite the employee's clothing, or

EXCEPTION: Subsection (b)(1)(B) does not apply to conductors that are capable of carrying, without failure, the maximum available fault current for the time the circuit protective devices take to interrupt the fault.

(C) The incident heat energy estimated under subsection (a)(2) of this section exceeds 2.0 cal/cm^2.

(2) Arc rating. The employer shall ensure that each employee exposed to hazards from electric arcs wears protective clothing and other protective equipment with an arc rating greater than or equal to the heat energy estimated under subsection (a)(2) of this section whenever that estimate exceeds 2.0 cal/cm^2. This protective equipment shall cover the employee's entire body, except as follows:

(A) Arc-rated protection is not necessary for the employee's hands when the employee is wearing rubber insulating gloves with protectors or, if the estimated incident energy is no more than 14 cal/cm^2, heavy-duty leather work gloves with a weight of at least 407 gm/m^2 (12 oz/yd2),

(B) Arc-rated protection is not necessary for the employee's feet when the employee is wearing heavy-duty work shoes or boots,

(C) Arc-rated protection is not necessary for the employee's head when the employee is wearing head protection meeting GISO, Section 3381 if the estimated incident energy is less than 9 cal/cm^2 for exposures involving single-phase arcs in open air or 5 cal/cm^2 for other exposures,

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(D) The protection for the employee's head may consist of head protection meeting GISO, Section 3381 and a faceshield with a minimum arc rating of 8 cal/cm^2 if the estimated incident-energy exposure is less than 13 cal/cm^2 for exposures involving single-phase arcs in open air or 9 cal/cm^2 for other exposures, and

(E) For exposures involving single phase arcs in open air, the arc rating for the employee's head and face protection may be 4 cal/cm^2 less than the estimated incident energy.

(3) Dates.

(A) The requirement in subsection (a)(2) of this section for the employer to make reasonable estimates of incident energy commences **[OAL will insert this date to be six months from the effective date of the regulation]**.

(B) The requirement in subsection (b)(1)(C) of this section for the employer to ensure that the outer layer of clothing worn by an employee is flame-resistant when the estimated incident heat energy exceeds 2.0 cal/ cm^2 commences **[OAL will insert this date to be six months from the effective date of the regulation]**.

(C) The requirement in subsection (b)(2) of this section for the employer to ensure that each employee exposed to hazards from electric arcs wears the required arc-rated protective equipment commences **[OAL will insert this date to be six months from the effective date of the regulation]**.

(c) Fuse Handling. When an employee must install or remove fuses with one or both terminals energized at more than 300 volts, or with exposed parts energized at more than 50 volts, the employer shall ensure that the employee uses tools or gloves rated for the voltage.
When an employee installs or removes expulsion-type fuses with one or both terminals energized at more than 300 volts, the employer shall ensure that the employee wears eye protection meeting the requirements of Section 3382, uses a tool rated for the voltage, and is clear of the exhaust path of the fuse barrel.

(d) Covered (Noninsulated) Conductors. The requirements of this section that pertain to the hazards of exposed live parts also apply when an employee performs work in proximity to covered (noninsulated) wires.

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(e) Non-Current-Carrying Metal Parts. Non-current-carrying metal parts of equipment or devices, such as transformer cases and circuit-breaker housings, shall be treated as energized at the highest voltage to which these parts are exposed, unless the employer inspects the installation and determines that these parts are grounded before employees begin performing the work.

(f) Opening and Closing Circuits Under Load. The employer shall ensure that devices used by employees to open circuits under load conditions are designed to interrupt the current involved and the devices used by employees to close circuits under load conditions are designed to safely carry the current involved.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 1. Low-Voltage Electrical Safety Orders
Article 4. Requirements for Electrical Installations

Amend Section 2340.17 to read:

§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:

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(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.

(d) Except for fuse replacement and other necessary access by qualified persons, the employer shall maintain guarding of energized parts within a compartment during operation and maintenance functions to prevent accidental contact with energized parts and to prevent dropped tools or other equipment from contacting energized parts.

(e) Temporary removal of guards. Before guards are removed from energized equipment, the employer shall install barriers around the work area to prevent employees who are not working on the equipment, but who are in the area, from contacting the exposed live parts.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 1. Definitions

Amend Section 2700 to add the following definitions within the existing definitions in alphabetical orders:

§2700. Definitions.

The following definitions of frequently used terms shall be accepted as the intended meanings of these terms whenever used in these High-Voltage Electrical Safety Orders.

NOTE: Definitions of other terms used in only one article are included in the front of that article.

*****

Aerial Lift. [No change in text.]
Affected Employee. An employee whose job requires him or her to operate or use a machine or equipment on which cleaning, repairing, servicing, setting-up, or adjusting operations are being performed under lockout or tagout, or whose job requires the employee to work in an area in which such activities are being performed under lockout or tagout.
Ambient Temperature. [No change in text.]

*****

Atmosphere. [No change in text.]
Authorized Employee or Person. For the purposes of Section 2940.13, a qualified person who locks out or tags out specific machines or equipment in order to perform cleaning, repairing, servicing, setting-up, and adjusting operations on that machine or equipment. An affected employee becomes an authorized employee when that employee's duties including performing cleaning, repairing, servicing, setting-up and adjusting operations covered under this section.
Authorized Person. [No change in text.]

*****

Barricade. Physical obstruction such as tapes, screens, ~~or~~ cones, or structures setup in a manner intended to warn and limit access to a hazardous area.
Barrier. Physical obstruction which is intended to prevent contact with energized lines or equipment or prevents unauthorized access to a work area.
Basic Impulse Level (BIL). (See Ratings.)
Bond. An electrical connection from one metallic element to another for the purpose of minimizing potential differences and providing for mitigation of leakage current and electrolytic action.
Bonding (Bonded). [No change in text.]

*****

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Current. [No change in text.]
Current Carrying Part. A conducting part connected in an electric circuit to a source of voltage.
Cutout. (See Switching Devices.)

*****

Electric Line Truck. [No change in text.]
Electric Supply Equipment. Equipment that produces, modifies, regulates, controls, or safeguards a supply of electric energy.
Electric Supply Lines. [No change in text.]
Electric Utility. An organization responsible for the installation, operation, or maintenance of an electric supply system.
Enclosed. [No change in text.]
Enclosed Space. A working space, such as a manhole, vault, tunnel, or shaft, that has a limited means of egress or entry, that is designed for periodic employee entry under normal operating conditions, and that, under normal conditions, does not contain a hazardous atmosphere, but may contain a hazardous atmosphere under abnormal conditions.
NOTE to the definition of "enclosed space":
The Division of Occupational Safety and Health (Division) does not consider spaces that are enclosed but not designed for employee entry under normal operating conditions to be enclosed spaces for the purposes of this section. Similarly, the Division does not consider spaces that are enclosed and that are expected to contain a hazardous atmosphere to be enclosed spaces for the purposes of this section. Such spaces meet the definition of permit spaces in Section 5157 of the General Industry Safety Orders or Article 37 of the Construction Safety Orders.
Enclosure. [No change in text.]
Energized Parts (Live Parts). [No change in text.]
Energy Isolating Device. A physical device that prevents the transmission or release of energy, including, but not limited to, the following: a manually operated electric circuit breaker, a disconnect switch, a manually operated switch, a slide gate, a slip blind, a line valve, blocks, and any similar device with a visible indication of the position of the device. (Push buttons, selector switches, and other control-circuit-type devices are not energy isolating devices.)
Energy Source. Any electrical, mechanical, hydraulic, pneumatic, chemical, nuclear, thermal, or other energy source that could cause injury to employees.
Entry (as used in Section 2943.1). The action by which a person passes through an opening into an enclosed space. Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.
Environment. (See Atmosphere, also.)

*****

Heating Equipment. [No change in text.]
High-Power Tests. Tests in which the employer uses fault currents, load currents, magnetizing currents, and line dropping currents to test equipment, either at the equipment's rated voltage or at lower voltages.

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High Voltage. [No change in text.]
High-Voltage System. [No change in text.]
High-Voltage Tests. Tests in which the employer uses voltages of approximately 1,000 volts as a practical minimum and in which the voltage source has sufficient energy to cause injury.
Hook Stick. (See Switch Stick.)

*****

Line Clearance Tree Trimming Operations. Operations which include the pruning, trimming, repairing, maintaining, chemical treatment, removal or cleaning clearing of trees, or cutting of brush and miscellaneous vegetation, that is within 10 ft. (305 cm) the vicinity of electric supply lines and equipment.
NOTE to the definition of "Line Clearance Tree Trimming Operations": See Sections 2950 and 2951 for minimum approach distances related to line clearance tree trimming operations.

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Metal-Enclosed. [No change in text.]
Minimum Approach Distance. The closest distance a qualified electrical worker and qualified line clearance tree trimmer may approach an energized or a grounded object.
Minimum Bending Radius. [No change in text.]

*****

Qualified Person (Qualified Employee). An employee (person) who by reason of experience or instruction is familiar with the operation to be performed and the hazards involved.

*****

Shielding Cable. [No change in text.]
Statistical Sparkover Voltage. A transient overvoltage level that produces a 97.72 percent probability of sparkover (that is, two standard deviations above the voltage at which there is a 50 percent probability of sparkover).
Statistical Withstand Voltage. A transient overvoltage level that produces a 0.14 percent probability of sparkover (that is, three standard deviations below the voltage at which there is a 50 percent probability of sparkover).
Stored-Energy Operation. [No change in text.]

*****

Switching Device. A manually operable device (unless otherwise stated in the HVESO) designed to close and/or open one or more electric circuits. Included in this category are circuit breakers, cutouts, disconnecting (or isolating) switches, disconnecting means, interrupter switches, and oil (filled) cutouts.
Switching Devices. [No change in text.]
System Operator. A qualified person designated to operate the system or its parts.
Tag. [No change in text.]

*****

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Vault. A room, above or below ground (including manholes) of fire-resistant construction, primarily used for installing, operating, or maintaining electrical equipment or cable. ~~to house electrical equipment.~~

Vented Vault. A vault that has provision for air changes using exhaust flue stacks (vault vents) and low-level air intakes operating on pressure and temperature differentials that provide for airflow that precludes a hazardous atmosphere from developing.

Ventilated. [No change in text.]

*****

Weatherproof. [No change in text.]

Work-Positioning Device System. A body belt or body harness system rigged to allow an employee to be supported on an elevated surface, such as a utility pole, tower leg, or wall, and work with both hands free while leaning.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 27. Transformers

Amend Section 2874 to read:

§2874. General.

*****

(f) Current transformer secondaries. The employer shall ensure that employees do not open the secondary of a current transformer while the transformer is energized. If the employer cannot deenergize the primary of the current transformer before employees perform work on an instrument, a relay, or other section of a current transformer secondary circuit, the employer shall bridge the circuit so that the current transformer secondary does not experience an open-circuit condition.

(g) Series Streetlighting.

(1) If the open circuit voltage exceeds 600 volts, the employer shall ensure that employees work on series street lighting circuits in accordance with Sections 2940.7, 2941, 2943, 2946 and 2940.15 of these Orders, as appropriate.

(2) Before any employee opens a series loop, the employer shall deenergize the street lighting transformer and isolate it from the source of supply or shall bridge the loop to avoid an open-circuit condition.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 29. Capacitors

Amend Section 2887 to read:

§2887. General.

This article covers the installation of capacitors on electric circuits and work other than installation performed by employees on capacitors and on lines connected to capacitors. Surge capacitors or capacitors included as a component part of other apparatus and conforming with the requirements of such apparatus are excluded from these requirements.
~~(Title 24, Part 3, Section 460-1)~~

NOTE: Authority cited: Section 142.3: Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 29. Capacitors

Amend Section 2893 to read:

§2893. Disconnecting Capacitors and Means for Discharge.

(a) Before employees work on capacitors, the employer shall disconnect the capacitors from energized sources and short circuit the capacitors. A means shall be provided to reduce the residual voltage of a capacitor to 50 volts or less within 5 minutes after the capacitor is disconnected from the source of supply. The employer shall ensure that the employee short circuiting the capacitors waits at least 5 minutes from the time of disconnection before applying the short circuit.

(b) A discharge circuit shall be provided with automatic means of connecting it to the terminals of the capacitor bank after disconnection of the capacitor from the source of supply. The windings of motors, or transformers, or of other equipment directly connected to capacitors without a switch or overcurrent device interposed shall meet the requirements of subsection (a) above.

(c) Capacitors shall not be worked on until after they have been short circuited and grounded. The employer shall short circuit any line connected to capacitors before the line is treated as deenergized. The internal discharge device provided in capacitors shall not be used as a substitute for externally short circuiting and grounding capacitors.

(d) Before employees handle the units, the employer shall short circuit each unit in series-parallel capacitor banks between all terminals and the capacitor case or its rack. If the cases of capacitors are on ungrounded substation racks, the employer shall bond the racks to ground.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 36. Work Procedures and Operating Procedures

Amend Section 2940 to read:

§2940. General Provisions.

(a) Safe Access. All work locations shall be safely accessible whenever work is to be performed.

(b) Employer's Responsibility. The employer shall furnish such safety devices and safeguards as may be necessary to make the employment or place of employment as free from danger to the safety and health of employees as the nature of the employment reasonably permits. The employer shall examine or test each safety device at such intervals as may be reasonably necessary to ensure that it is in good condition and adequate to perform the function for which it is intended. Any device furnished by the employer found to be unsafe shall be repaired or replaced.

(1) Employees shall be instructed to inspect each safety device, tool or piece of equipment, each time it is used and to use only those in good condition. The employer shall require the use of safety devices and safeguards where applicable.

(2) The training shall establish employee proficiency in the work practices required by this section and shall introduce the procedures necessary for compliance with these Orders.

(3) The employer shall ensure that each employee has demonstrated proficiency in the work practices involved before that employee is to be considered properly instructed/trained commensurate with the requirements of this section and Section 3203 of the General Industry Safety Orders.

*****

(e) Information Transfer.

(1) Communication between employers. Before work begins, employers shall communicate to each other the following:

(A) The characteristics of the installation that are related to the safety of the work to be performed and are listed in subsections (f)(1)(A) through (f)(1)(E) of this section.

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(B) Conditions that are related to the safety of the work to be performed, that are listed in subsections (f)(1)(F) through(f)(1)(H) of this section.

(C) Information about the design and operation of the installation in order to conduct the assessments required by this section.

(D) Any other information about the design and operation of the installation that is requested and is related to the protection of the employees.

(E) Unique hazardous conditions related to the job.

(F) Any unanticipated hazardous conditions discovered or found while performing work. Employers shall provide this information to the other employer within 2 working days after discovering the hazardous condition.

(G) The employers shall coordinate their work rules and procedures so all employees are protected as required by these Orders.

(2) The employer shall ensure that each of their respective employees are instructed in the hazardous conditions relevant to the employee's work as specified in subsection (e)(1) of this section.

(f) Existing Characteristics and Conditions.

(1) Existing characteristics and conditions of electric lines and equipment that are related to the safety of the work to be performed shall be determined before work on or near the lines or equipment is started. Such characteristics and conditions include, but are not limited to:

(A) The nominal voltages of lines and equipment,

(B) The maximum switching-transient voltages,

(C) The presence of hazardous induced voltages,

(D) The presence of protective grounds and equipment grounding conductors,

(E) The locations of circuits and equipment, including electric supply lines, communication lines, and fire protective signaling circuits,

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(F) The condition of protective grounds and equipment grounding conductors,

(G) The condition of poles, and

(H) Environmental conditions relating to safety.

(g) Conductive Articles. When an employee performs work within reaching distance of exposed energized parts of equipment, the employer shall ensure that the employee removes all exposed conductive articles, such as keychains or watch chains, rings, or wrist watches or bands, unless such articles do not increase the hazards associated with contact with the energized parts.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 36. Work Procedures and Operating Procedures

Amend Section 2940.1 to read:

§2940.1. Voltage Determination and Energized Equipment or Systems.

(a) All electrical equipment and systems shall be treated as energized until tested or otherwise proven to be deenergized.

~~(a)~~(b) Operating voltage of equipment or conductors shall be determined before working on or near energized parts.

(c) The employer shall provide and require employees to use suitable personal protective equipment when testing or determining voltage.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 36. Work Procedures and Operating Procedures

Amend Section §2940.2 to read:

§2940.2. ~~Clearances~~ Minimum Approach Distances.

(a) The employer shall establish minimum approach distances using one of the following methods:

(1) Distances no less than computed by Table 2940.2-1 for AC Systems or Table 2940.2-6 for DC Systems using maximum anticipated per-unit transient overvoltage determined by an engineering analysis.

(A) No later than **[OAL will insert this date to be six months from the effective date of the regulation]** anticipated per-unit transient overvoltage, phase-to-ground, through an engineering analysis.

When the employer uses portable protective gaps to control the maximum transient overvoltage, the value of the maximum anticipated per-unit transient overvoltage, phase-to-ground, shall provide for five standard deviations between the statistical spark over voltage of the gap and the statistical withstand voltage corresponding to the electrical component of the minimum approach distance. The employer shall make any engineering analysis conducted to determine maximum anticipated per unit transient overvoltage available upon request to employees and to the Chief of the Division or designee for examination and copying.

(2) The minimum approach distances in Table 2940.2-3, Table 2940.2-4, and the last row of Table 2940.2-6.

NOTE to subsection (a)(2): Approach distances in Table 2940.2-3 and Table 2940.2-4 assume a maximum anticipated per-unit transient overvoltage in Table 2940.2-5.

(A) Minimum approach distances shall be adjusted to account for work locations above 3,000 feet using altitude correction factors (Table 2940.2-7).

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(3) Until **[OAL will insert this date to be six months from the effective date of the regulation]**, employers may utilize the minimum approach distances specified in Appendix A, Table 6 or Tables 10 to 13.

~~(a)~~(b) No employee shall be permitted to approach or take any conductive object without an approved insulating handle closer to exposed energized parts than the employer established minimum approach distances ~~shown in Table 2940.2-1 through Table 2940.2-3~~ unless one of the following is met:

(1) The employee is insulated or guarded from the energized part (rubber insulating gloves or gloves with sleeves rated for the voltage involved shall be considered insulation of the employee from the energized part) upon which the employee is working provided that the employee has control of the part in a manner sufficient to prevent exposure to uninsulated portions of the employee's body), or

(2) The energized part is insulated or guarded from the employee and any other conductive object at a different potential.

(c) Type of Insulation.

(1) When an employee uses rubber insulating gloves as insulation from energized parts (under subsection (b)(1) of this section), the employer shall ensure that the employee also uses rubber insulating sleeves. However, an employee need not use rubber insulating sleeves if:

(A) Exposed energized parts on which the employee is not working are insulated from the employee; and

(B) When installing insulation for purposes of subsection (c)(1)(A) of this section, the employee installs the insulation from a position that does not expose his or her upper arm to contact with other energized parts.

(2) When an employee uses rubber insulating gloves or rubber insulating gloves and sleeves as insulation from energized parts under subsection (b)(1) of this section, the employer shall ensure that the employee:

(A) Puts on the rubber insulating gloves and sleeves in a position where he or she cannot reach into the minimum approach distance, established by the employer under Section 2940.2 of these Orders and

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(B) Does not remove the rubber insulating gloves and sleeves until he or she is in a position where he or she cannot reach into the minimum approach distance, established by the employer under subsection (a).

~~(b)~~(d) Working Position.

(1) When performing work with live line tools, minimum ~~clear~~ approach distances in accordance with subsection (a) ~~Table 2940.2-1 through~~ ~~Table 2940.2-3~~ shall be maintained. Conductor support tools, such as link sticks, strain carriers, and insulator cradles, shall be permitted to be used provided that the clear insulation is at least as long as the insulator string or the minimum approach distance specified in subsection (a) ~~Table 2940.2-1 through Table 2940.2-3 for the operating voltage~~.

~~TABLE 2940.2-1~~	
~~ALTERNATING CURRENT – MINIMUM~~	
~~APPROACH DISTANCE~~	
~~Nominal Voltage in~~	*~~Distance~~*
~~Kilovolts Phase to Phase~~	*~~Phase to Ground Exposure~~*
	~~ft-in~~
~~0.6 to 15~~	~~2-1~~
~~15.1 to 36.0~~	~~2-4~~
~~36.1-46.0~~	~~2-7~~
~~46.1-72.5~~	~~3-0~~
~~72.6-121~~	~~3-4~~
~~121.1-145~~	~~3-7~~
~~145.1-169~~	~~4-0~~
~~169.1-242~~	~~5-3~~
~~242.1-362~~	~~8-6~~
~~362.1-552~~	~~11-3~~

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~~552.1-765~~	~~15-0~~

~~NOTE 1: These distances take into consideration the highest switching surge an employee will be exposed to on any system with air as the insulating medium and the maximum voltages shown.~~
~~NOTE 2: The clear live-line tool distance shall equal or exceed the values for the indicated voltage ranges.~~

Table 2940.2-1 AC Live-Line Work Minimum Approach Distance	
The minimum approach distance (MAD; in meters) shall conform to the following equations.	
For phase-to-phase system voltages of 601V to 5 kV: [1]	
MAD = *M* + *D*, where	
D = 0.02 m	D is the electrical component of the minimum approach distance
M = 0.31 m for voltages up to 750V and 0.61 m otherwise	M is the inadvertent movement factor
For phase-to-phase system voltages of 5.1 kV to 72.5V: [1,4]	
MAD = *M* + *AD*, where	
M = 0.61 m	M is the inadvertent movement factor
A = the applicable value from 2940.2-7	A is the altitude correction factor
D = the value from 2940.2-2 corresponding to the voltage and exposure or the value of the electrical component of the minimum approach distance calculated using the method provided in Appendix A to this article	D is the electrical component of the minimum approach distance
For phase-to-phase system voltages of more than 72.5 kV, nominal: [2, 4]	
$MAD = 0.3048(C+a)V_{L\text{-}G}TA+M$, where	
C =	0.01 for phase-to-ground exposures that the employer can demonstrate consist only of air across the approach distance (gap), 0.01 for phase-to-phase exposures if the employer

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	can demonstrate that no insulated tool spans the gap and the no large conductive object is in the gap, or 0.011 otherwise				
V_{L-G} =	phase-to-ground rms voltage, in kV				
T =	maximum anticipated per-unit transient overvoltage; for phase-to-ground exposures, T equals T_{L-G}, the maximum per-unit transient overvoltage, phase-to-ground, determined by the employer under subsection (a)(1)(A) of this section; for phase-to-phase exposures, T equals $1.35T_{L-G}+0.45$				
A =	altitude correction factor from 2940.2-7				
M =	0.31 m, the inadvertent movement factor				
a =	saturation factor, as follows:				
Phase-to-Ground Exposure					
$V_{Peak} = T_{L-G}V_{L-G}\sqrt{2}$	635 kV or less	635.1 to 915 kV	915.1 to 1,050 kV	More than 1,050 kV	
A	0	$(V_{Peak}-635)/140{,}000$	$(V_{Peak}-645)/135{,}000$	$(V_{Peak}-675)/125{,}000$	
Phase-to-Ground Exposure[3]					
$V_{Peak}=(1.35T_{L-G}+0.45)V_{L-g}\sqrt{2}$	630 kV or less	630.1 to 848 kV	848.1 to 1,131 kV	1,131.1 to 1,485 kV	More than 1,485 kV
A	0	$(V_{Peak}-630)/155{,}000$	$(V_{Peak}-633.6)/152{,}207$	$(V_{Peak}-628)/$	

[1] Employers may use the minimum approach distances in Table 2940.2-3. If the worksite is at an elevation of more than 900 meters (3,000 feet), see footnote 1 to Table 2940.2-3.

[2] Employers may use the minimum approach distances in Table 2940.2-4 except that the employer may not use the minimum approach distances in Table 2940.2-4 for phase-to-phase exposures if an insulated tool spans the gap or if any large conductive object is in the gap. If the worksite is at an elevation of more than 900 meters (3,000 feet), see footnote 1 to Table 2940.2-4. Employers may use the minimum approach distance in Table 14 through Table 21 in Appendix A to this article, which calculated MAD for various values of T, provided the employer follows the notes to those tables.

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[3] Use the equations for phase-to-ground exposures (with VPeak for phase-to-phase exposures) unless the employer can demonstrate that no insulated tool spans the gap and that no large conductive objects is in the gap.

[4] Until **[OAL will insert this date to be six months from the effective date of the regulation]**, employees may use the minimum approach distances in Table 6 in Appendix A of this Article.

~~TABLE 2940.2-2~~							
~~AC LIVE-LINE WORK MINIMUM~~							
~~APPROACH DISTANCE~~							
~~WITH OVERVOLTAGE FACTOR~~							
~~PHASE TO GROUND EXPOSURE~~							
~~Max~~							
~~anticipated~~							
~~per-unit~~	*~~Distances in feet-inches~~*						
~~transient~~							
~~over~~	*~~Maximum Phase to Phase Voltage in Kilovolts~~*						
~~voltage~~							
	~~121~~	~~145~~	~~169~~	~~242~~	~~362~~	~~552~~	~~800~~
~~1.5~~						~~6-0~~	~~9-8~~
~~1.6~~						~~6-6~~	~~10-8~~
~~1.7~~						~~7-0~~	~~11-8~~
~~1.8~~						~~7-7~~	~~12-8~~
~~1.9~~						~~8-1~~	~~13-9~~
~~2.0~~	~~2-5~~	~~2-9~~	~~3-0~~	~~3-10~~	~~5-3~~	~~8-9~~	~~14-11~~
~~2.1~~	~~2-6~~	~~2-10~~	~~3-2~~	~~4-0~~	~~5-5~~	~~9-4~~	
~~2.2~~	~~2-7~~	~~2-11~~	~~3-3~~	~~4-1~~	~~5-9~~	~~9-11~~	
~~2.3~~	~~2-8~~	~~3-0~~	~~3-4~~	~~4-3~~	~~6-1~~	~~10-6~~	

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~~2.4~~	~~2-9~~	~~3-1~~	~~3-5~~	~~4-5~~	~~6-4~~	~~11-3~~	
~~2.5~~	~~2-9~~	~~3-2~~	~~3-6~~	~~4-6~~	~~6-8~~		
~~2.6~~	~~2-10~~	~~3-3~~	~~3-8~~	~~4-8~~	~~7-1~~		
~~2.7~~	~~2-11~~	~~3-4~~	~~3-9~~	~~4-10~~	~~7-5~~		
~~2.8~~	~~3-0~~	~~3.5~~	~~3-10~~	~~4-11~~	~~7-9~~		
~~2.9~~	~~3-1~~	~~3-6~~	~~3-11~~	~~5-1~~	~~8-2~~		
~~3.0~~	~~3-2~~	~~3-7~~	~~4-0~~	~~5-3~~	~~8-6~~		

~~NOTE 1: The distance specified in this table may be applied only where the maximum anticipated per-unit transient overvoltage has been determined by engineering analysis and has been supplied by the employer. Table 2940.2-1 applies otherwise.~~
~~NOTE 2: The distances specified in this table are the air and live-line tool distances.~~

TABLE 2940.2-2 ELECTRICAL COMPONENT OF THE MINIMUM APPROACH DISTANCE (D; IN METERS) AT 5.1 TO 72.5 kV		
Nominal voltage (kV) phase-to-phase	Phase-to-ground exposure	Phase-to-phase exposure
	D (m)	D (m)
5.1 to 15.0	0.04	0.07
15.1 to 36.0	0.16	0.28
36.1 to 46.0	0.23	0.37
46.1 to 72.5	0.39	0.59

~~TABLE 2940.2-3~~	
~~DC LIVE-LINE WORK MINIMUM APPROACH DISTANCE~~	
~~WITH OVERVOLTAGE FACTOR~~	
	~~*Distance in feet-inches*~~
~~*Maximum anticipated*~~	~~*Maximum line-to-ground*~~
~~*per-unit transient*~~	~~*voltage in kilovolts*~~

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overvoltage					
	250	400	500	600	750
1.5 or lower	3-8	5-3	6-9	8-7	11-10
1.6	3-10	5-7	7-4	9-5	13-1
1.7	4-1	6-0	7-11	10-3	14-4
1.8	4-3	6-5	8-7	11-2	15-9

NOTE 1: The distances specified in this table may be applied only where the maximum anticipated per-unit transient overvoltage has been determined by engineering analysis and has been supplied by the employer. However, if the transient overvoltage factor is not known, a factor of 1.8 shall be assumed.
NOTE 2: The distance specified in this table are the air and live-line tool distances.

(c) Minimum approach distance (Tables 2940.2-1 through 2940.2-3) shall be adjusted to account for work locations above 3,000 feet using altitude correction factors (Table 2940.2-4).

TABLE 2940.2-3 ALTERNATIVE MINIMUM APPROACH DISTANCES (IN METERS OR FEET) FOR VOLTAGES OF 72.5 kV AND LESS [1]

Nominal voltage (kV) phase-to-phase	Distance			
	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
0.601 to 0.750 [2]	0.33	1.09	0.33	1.09
0.751 to 5.0	0.63	2.07	0.63	2.07
5.1 to 15.0	0.65	2.14	0.68	2.24
15.1 to 36.0	0.77	2.53	0.89	2.92
36.1 to 46.0	0.84	2.76	0.98	3.22
46.1 to 72.5	1.00	3.29	1.20	3.94

[1] Employers may use the minimum approach distances in this table provided the worksite is at an elevation of 900 meters (3,000 feet) or less. If employees will be working at elevations greater than 900 meters (3,000 feet) above

mean sea level, the employer shall determine minimum approach distances by multiplying the distances in this table by the correction factor in Table 2940.2-7 corresponding to the altitude of the work.
[2] For single-phase systems, use voltage-to-ground.

TABLE 2940.2-4 ALTERNATIVE MINIMUM APPROACH DISTANCES FOR VOLTAGES OF MORE THAN 72.5 kV [1, 2, 3]

Voltage range phase to phase (kV)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
72.6 to 121.0	1.13	3.71	1.42	4.66
121.1 to 145.0	1.30	4.27	1.64	5.38
145.1 to 169.0	1.46	4.79	1.94	6.36
169.1 to 242.0	2.01	6.59	3.08	10.10
242.1 to 362.0	3.41	11.19	5.52	18.11
362.1 to 420.0	4.25	13.94	6.81	22.34
420.1 to 550.0	5.07	16.63	8.24	27.03
550.1 to 800.0	6.88	22.57	11.38	37.34

[1] Employers may use the minimum approach distances in this table provided the worksite is at an elevation of 900 meters (3,000 feet) or less. If employees will be working at elevations greater than 900 meters (3,000 feet) above mean sea level, the employer shall determine minimum approach distances by multiplying the distances in this table by the correction factor in 2940.2-7 corresponding to the altitude of the work.

[2] Employers may use the phase-to-phase minimum approach distances in this table provided that no insulated tool spans the gap and no large conductive object is in the gap.

[3] The clear live-line tool distance shall equal or exceed the values for the indicated voltage ranges.

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TABLE 2940.2-5 ASSUMED MAXIMUM PER-UNIT TRANSIENT OVERVOLTAGE		
Voltage range (kV)	Type of current (AC or DC)	Assumed maximum per-unit transient overvoltage
72.6 to 420.0	AC	3.5
420.1 to 550.0	AC	3.0
550.1 to 800.0	AC	2.5
250 to 750	DC	1.8

TABLE 2940.2-6 DC LIVE-LINE MINIMUM APPROACH DISTANCE WITH OVERVOLTAGE FACTOR[1]										
Maximum Anticipated Transient Overvoltage	Maximum Line-To-Ground Voltage (kV)									
	250 (kV)		400 (kV)		500 (kV)		600 (kV)		750 (kV)	
	m	ft	M	ft	m	ft	m	ft	m	ft
1.5 or less	1.12	3.67	1.60	5.25	2.06	6.76	2.62	8.59	3.61	11.84
1.6	1.17	3.84	1.69	5.54	2.24	7.35	2.86	9.38	3.98	6.37
1.7	1.23	4.03	1.85	6.07	2.42	7.94	3.12	10.23	4.37	14.33
1.8	1.28	4.20	1.95	6.40	2.62	8.59	3.39	11.12	4.79	15.71

[1] The distances specified in this table are for air, bare-hand, and live-line tool conditions. If employees will be working at elevations greater than 900 meters (3,000 feet) above mean sea level, the employer shall determine minimum approach distances by multiplying the distances in this table by the correction factor in Table 2940.2-7 corresponding to the altitude of the work.

TABLE ~~2940.2-4~~ 2940.2-7 ALTITUDE CORRECTION FACTOR		
Altitude (m)	*Altitude (ft)*	*Correction Factor*
0 to 900	Sea level to 3000	1.00
901 to 1,200	3,001 to 4,000	1.02

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1,201 to 1,500	4,001-5,000	1.05
1,501 to 1,800	5,001-6,000	1.08
1,801 to 2,100	6,001-7,000	1.11
2,101 to 2,400	7,001-8,000	1.14
2,401 to 2,700	8,001-9,000	1.17
2,701 to 3,000	9,001-10,000	1.20
3,001 to 3,600	10,001-12,000	1.25
3,601 to 4,200	12,001-14,000	1.30
4,201 to 4,800	14,001-16,000	1.35
4,801 to 5,400	16,001-18,000	1.39
5,401 to 6,000	18,001-20,000	1.44

~~NOTE 1: Minimum approach distances from Table 2940.2-1 through Table 2940.2-3 shall be multiplied to the corresponding correction factor in Table 2940.2-4 to obtain the correct minimum approach distance, adjusted to account for higher altitudes.~~
~~NOTE 2: The data used to formulated this was obtained from test data taken with standard atmospheric condition. Standard atmospheric conditions are defined as temperatures above freezing, wind less than 15mph, unsaturated air, normal barometer (30 inches of mercury at sea level0, uncontaminated air, and clean and dry insulators. If standard atmospheric conditions do not exist, extra care must be taken.~~

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 36. Work Procedures and Operating Procedures

Amend Section 2940.5 to read:

§2940.5. Work ~~o~~<u>O</u>ver or ~~n~~<u>N</u>ear Water.

<u>(a)</u> When work is performed over or near water and when danger of drowning exists, suitable protection shall be provided <u>as required by Section 3389 of the General Industry Safety Orders</u>.

<u>(b) An employee may cross streams or other bodies of water only if a safe means of passage, such as a bridge, is provided.</u>

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 36. Work Procedures and Operating Procedures

Amend Section 2940.6 to read:

§2940.6. Tools and Protective Equipment.

(a) Insulating Equipment.

(1) Insulating equipment designed for the voltage levels to be encountered shall be provided and the employer shall ensure that they are used by employees as required by this section. This equipment shall meet the electrical and physical requirements contained in the standards <u>for marking, inspection, performance and testing</u> shown in Appendix C.

*****

(4) The employer is responsible for the periodic visual and electrical re-testing of all insulating gloves, sleeves and blankets. The following maximum re-testing intervals for the items covered by the listed ASTM standards shall apply:

GLOVES, SLEEVES, BLANKETS,
AND OTHER INSULATING EQUIPMEN<u>T</u>
(In-service care)

ELECTRICAL TEST INTERVALS	
ASTM STANDARD	MONTHS
Standard Specification for In-Service Care of Insulating Gloves and Sleeves, ASTM F 496~~-02a~~<u>08</u>	*6 months for gloves *12 months for sleeves
Standard Specification for In-Service Care of Insulating Blankets, ASTM F 479-~~06~~<u>(2011)</u>	*12 months for blankets
Standard Specification for In-Service Care of Insulating Line Hose and Covers, ASTM F 478-~~92~~<u>09</u> ~~(Reapproved 1999)~~	For line hose and covers (When found to be damaged or defective)

*Gloves, sleeves, and blankets that have been electrically tested but not issued for service shall not be placed into service unless they have been electrically tested within the previous twelve months.

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(11) Repaired insulating equipment shall be retested before it may be used by employees.

(12) The employer shall certify that equipment has been tested in accordance with the requirements of Appendix C of this Article. The certification shall identify the equipment that passed the test and the date it was tested and shall be made available upon request to the Division of Occupational Safety and Health employees or authorized representatives.

(b) 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.~~

(1) Climbing or changing location. Qualified employees climbing or changing locations on poles, towers, or similar structures shall use fall protection equipment.

EXCEPTION to subsection (b)(1): Employer can demonstrate that fall protection is infeasible or creates a greater hazard.

(c) Linemen's Body Belts, Safety Straps and Lanyards.

(1) Linemen's body belts and safety straps purchased after January 1, 1993, shall be labeled as meeting the requirements contained in ASTM F 887-91, Standard Specifications for Personal Climbing Equipment.

EXCEPTION: Linemen's body belts and safety straps purchased before January 1, 1993 which are labeled/tagged as meeting either the ANSI A10.14 or ASTM F 887 Standard in effect at the time of purchase.

(2) Personal fall arrest and positioning equipment used by employees who are exposed to hazards from flames or electric arcs, as determined by the employer under Section 2940.11, shall be labeled as meeting ASTM F 887-12^{E1}, Standard Specifications for Personal Climbing Equipment which is hereby incorporated by reference.

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~~(2)~~ (3) Body belts, safety straps, and lanyards shall be inspected by a qualified person each day before use to determine that they are safe. Those determined to be unsafe shall be immediately removed from service.

~~(3)~~ (4) Safety straps shall not be used when any portion of the red safety marker strip in the strap is exposed.

~~(4) Leather shall not be used for safety straps.~~

(d) Portable Ladders and Platforms.

(1) Portable conductive ladders shall not be used near energized conductors or exposed energized parts of equipment except as may be necessary in specialized high-voltage work such as in high-voltage substations where non-conductive ladders might present a greater hazard than conductive ladders.

(2) Portable conductive ladders shall be legibly marked with signs reading "Caution-Do Not Use Near Energized Electrical Equipment" or equivalent wording.

(3) Portable ladders used on structures shall be secured to prevent them from being accidentally displaced.

(4) The requirements for portable ladders contained in Section 3276 apply in addition to the requirements of this section except for Section 3276(e)(7) and (e)(9) when used in conjunction with overhead linework.

(5) In the configurations in which they are used, portable platforms and ladders shall be capable of supporting without failure at least 2.5 times the maximum intended load.

(6) Portable ladders and platforms shall not be loaded in excess of the working loads for which they are designed.

(e) Live Line Tools.

(1) Live line tools shall meet the requirements specified in Appendix "B."

(2) Daily Inspection. Live line tools shall be visually inspected for defects before use each day. ~~Tools to be used shall be wiped clean and if defects are indicated such tools shall not be used.~~

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(A) Tools to be used shall be wiped clean. If any defect or contamination that could adversely affect the insulating qualities or mechanical integrity of the live-line tool is present after wiping, the tool shall be removed from service.

NOTE to subsection (e)(2): Examples of defects that could adversely affect insulating qualities or mechanical integrity are found in the Institute of Electrical and Electronics Engineers', IEEE Guide for Maintenance Methods on Energized Power Lines, IEEE Std 516TM-2009, Sections 5.7 and 5.8.

(3) Biennial Inspection. Live-line tools used for primary employee protection shall be removed from service every 2 years, and whenever required under subsection (e)(2) of this section, for examination, cleaning, repair, and testing as follows:

(A) Each tool shall be thoroughly examined for defects.

(B) If a defect or contamination that could adversely affect the insulating qualities or mechanical integrity of the live-line tool is found, the tool shall be repaired and refinished or shall be permanently removed from service. If no such defect or contamination is found, the tool shall be cleaned and waxed.

(C) The tool shall be tested under the following conditions:

1. After the tool has been repaired or refinished regardless of composition or

2. Live line tool made of wood or hollow fiberglass reinforced plastic (FRP).

EXCEPTION to subsection (e)(3)(C): Live line tool made of solid or foam-filled FRP that has been examined and no repair or refinishing was performed, and the employer can demonstrate that the tool has no defects that could cause it to fail during use.

(D) The test method used shall be designed to verify the tool's integrity along its entire working length and, if the tool is made of fiberglass-reinforced plastic, its integrity under wet conditions.

(E) The voltage applied during the tests shall be as follows:

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1. 246,100 volts per meter (75,000 volts per foot) of length for 1 minute if the tool is made of fiberglass, or

2. 164,000 volts per meter (50,000 volts per foot) of length for 1 minute if the tool is made of wood, or

3. Other tests that the employer can demonstrate are equivalent.

NOTE to subsection (e): Guidelines for the examination, cleaning, repairing, and in-service testing of live-line tools are specified in the Institute of Electrical and Electronics Engineers', IEEE Guide for Maintenance Methods on Energized Power Lines, IEEE Std 516^{TM}-2009.

(f) Conductive measuring tapes, ropes or similar measuring devices shall not be used when working on or near exposed energized conductors or parts of equipment.

(g) Handtools and Pneumatic Tools.

(1) Hydraulic tools which are used on or near exposed energized conductors or equipment shall use non-conductive hoses. All valves, pipes, non-conductive hoses, filters and fittings ~~having~~ shall have adequate strength for normal operating pressures. The provisions of Section 3556, General Industry Safety Orders, Title 8, California Code of Regulations, shall also apply.

(A) The hydraulic system supplying a hydraulic tool used where it may contact exposed live parts shall provide protection against loss of insulating value, for the voltage involved, due to the formation of a partial vacuum in the hydraulic line.

(B) Employees shall be instructed to not use any part of their bodies to locate, or attempt to stop, a hydraulic leak.

(2) Pneumatic tools which are used on or near exposed energized conductors or equipment shall:

(A) have non-conductive hoses having adequate strength for the normal operating pressures and

(B) have an accumulator on the compressor to collect moisture.

NOTE: For the purposes of subsections (f) and (g), energized conductors on which temporary insulating devices have been installed shall be considered “exposed.”

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(3) Pressure shall be released before connections are broken, unless quick acting, self-closing connectors are used. Hoses shall not be kinked.

(4) Cord and plug-connected equipment shall be grounded in accordance with Sections 2395.45 and 2395.59.

EXCEPTION to subsection (g)(4): This option may not be used where the introduction of the ground into the work environment increases the hazard to an employee.

(h) Grounding requirements for portable and vehicle mounted generators shall be in accordance with Section 2395.6.

~~(h)~~(i) Conductive Objects. Conductive objects of a length capable of contacting energized conductors shall not be carried into the level of such conductors unless suitable means are taken to prevent accidental contact.

~~(i)~~(j) Lines used for emergency rescue such as lowering a person to the ground shall have a minimum breaking strength of 2650 pounds and shall be readily available on the job site.

~~(j)~~(k) Apparel. The employer shall ensure that each employee who is exposed to the hazards of flames or electric arcs does not wear clothing that, when exposed to flames or electric arcs, could increase the extent of injury that would be sustained by the employee. This subsection prohibits clothing made from the following types of fabrics, either alone or in blends, unless the employee can demonstrate that the fabric has been treated with flame retardant: acetate, nylon, polyester, and rayon.

NOTE: For apparel requirements for the power generation, transmission, and distribution industry, see Section 2940.11 for the protection from flames and electric arcs.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Amend Section 2940.7 to read:

§2940.7. Mechanical Equipment.

(a) General.

*****

(3) Hydraulic fluids used for the insulated sections of derrick trucks, aerial lifts, and hydraulic tools which are used on or near energized conductors or equipment shall ~~be of the insulating type.~~ <u>provide insulation for the voltage involved.</u>

(b) Aerial Lifts.

*****

(6) Clearances. Metal booms, metal baskets, or metal platforms of personnel aerial lift equipment operated in accordance with Section 2949 shall not be brought closer than the distances specified in Section <u>2940.2</u> ~~2940.2(b) Table 2940.2~~ to any exposed energized conductors or equipment.

<u>EXCEPTION: The insulated portion of an aerial lift operated by a qualified employee in the lift is exempt from this requirement if the applicable minimum approach distance is maintained between the uninsulated portions of the aerial lift and exposed objects having a different electrical potential.</u>

*****

(c) Derrick Trucks, Cranes and Other Lifting Equipment.

(1) Derrick trucks, cranes and other lifting equipment shall comply with Articles 91 through 101 of the General Industry Safety Orders except:

(A) Section 2946, which contains provisions to prevent accidents due to overhead high voltage lines.

(B) Section 2940.2, which prescribes minimum approach distances for qualified electrical workers performing work.

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(C) Derrick trucks (electric line trucks) shall not be required to comply with ANSI B30.5 and B30.6 as referenced in Section 4884, General Industry Safety Orders, Title 8, California Code of Regulations.

(2) For work to be performed by qualified electrical workers, a designated qualified employee other than the equipment operator shall observe the approach distance to exposed lines and equipment and provide timely warnings before the minimum approach distance required by Section 2940.2 is reached, unless the employer can demonstrate that the operator can accurately determine that the minimum approach distance is being maintained.

(3) Each employee shall be protected from hazards that could arise from mechanical equipment contact with energized lines or equipment. The measures used shall ensure that employees will not be exposed to hazardous differences in electric potential. Unless the employer can demonstrate that the methods in use protect each employee from the hazards that could arise if the mechanical equipment contacts the energized line or equipment, the measures used shall include all of the following techniques:

(A) Using the best available ground to minimize the time the lines or electric equipment remain energized,

(B) Bonding mechanical equipment together to minimize potential differences,

(C) Providing ground mats to extend areas of equipotential, and

(D) Employing insulating protective equipment or barricades to guard against any remaining hazardous electrical potential differences.

NOTE to subsection (c)(3): Appendix E to this section contains information on hazardous step and touch potentials and on methods of protecting employees from hazards resulting from such potentials.

~~(2)~~(4)With the exception of equipment certified for work on the proper voltage, mechanical equipment shall not be operated closer to any energized conductor or exposed energized parts of equipment than the clearances set forth in Section 2940.2 ~~2940.2(b) Table 2940.2~~ unless, in addition to the requirements of Section 1612.3:

(A) an insulated barrier is installed between the energized part and the mechanical equipment, or

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(B) the mechanical equipment is insulated.

~~(3)~~(5) When setting, moving, or removing poles using cranes, derricks, gin poles, A-frames, or other mechanized equipment near energized conductors or equipment, precautions shall be taken to avoid contact with energized conductors or exposed energized parts of equipment except where barriers or protective devices are used.

(6) When a pole is set, moved, or removed near an exposed energized overhead conductor, the employer shall ensure that each employee wears electrical protective equipment or uses insulated devices when handling the pole and that no employee contacts the pole with uninsulated parts of his or her body.

*****

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Amend Section 2940.8 to read:

§2940.8. Material Handling.

*****

(c) Storage. When materials or equipment are stored under energized bus, energized conductors, or near exposed energized equipment, applicable clearances shall be maintained as stated in Section 2946 Table ~~1~~<u>2</u>, except when such work is performed by qualified electrical workers, or as provided in Section 2944~~(c)(3) and (c)(4).~~ <u>(g)(3) and (g)(4).</u>

*****

(f) Damaged or unstable poles, or sections of poles shall be guyed, braced or otherwise securely supported during pole removal operations.

<u>(g) To protect employees from falling into holes used for placing poles, the employer shall physically guard the holes, or ensure that employees attend the holes, whenever anyone is working nearby.</u>

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Add new Section 2940.11 to read:

§2940.11. Protection From Flames and Electric Arcs.

Scope: This section covers the construction, operation, and maintenance of electric power generation, control, transformation, transmission, and distribution lines and equipment. This includes related equipment for the purpose of communication or metering that are accessible only to qualified employees.

(a) Hazard Assessment.

(1) The employer shall assess the workplace in accordance with GISO, Section 3203 to identify employees exposed to hazards from flames or from electric arcs.

(2) For each employee exposed to hazards from electric arcs, the employer shall make a reasonable estimate of the incident heat energy to which the employee would be exposed.

NOTE 1 to subsection (a)(2): Appendix D to this article provides guidance on estimating available heat energy. The Division of Occupational Safety and Health will deem employers following the guidance in Appendix D to this article to be in compliance with subsection (a)(2) of this section. An employer may choose a method of calculating incident heat energy not included in Appendix D to this article if the chosen method reasonably predicts the incident energy to which the employee would be exposed.

NOTE 2 to subsection (a)(2): This subsection does not require the employer to estimate the incident heat energy exposure for every job task performed by each employee. The employer may make broad estimates that cover multiple system areas provided the employer uses reasonable assumptions about the energy-exposure distribution throughout the system and provided the estimates represent the maximum employee exposure for those areas. For example, the employer could estimate the heat energy just outside a substation feeding a radial distribution system and use that estimate for all jobs performed on that radial system.

(b) Selection and Prohibited Clothing. The employer shall select the apparel based on the hazard assessment in subsection (a)(2) and shall ensure that each employee who is exposed to hazards from flames or electric arcs is provided suitable apparel in accordance with the requirements of

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Section 2940.6(k). The employer shall not select the apparel that could melt onto his or her skin or that could ignite and continue to burn when exposed to flames or the heat energy estimated under subsection (a)(2) of this section.

(1) Flame-resistant clothing. The employer shall ensure that the outer layer of clothing worn by an employee, except for clothing not required to be arc rated under subsections (b)(2)(A-E) of this section, is flame resistant under any of the following conditions:

(A) The employee is exposed to contact with energized circuit parts operating at more than 600 volts,

(B) An electric arc could ignite flammable material in the work area that, in turn, could ignite the employee's clothing,

(C) Molten metal or electric arcs from faulted conductors in the work area could ignite the employee's clothing, or

EXCEPTION: Subsection (b)(1)(C) does not apply to conductors that are capable of carrying, without failure, the maximum available fault current for the time the circuit protective devices take to interrupt the fault.

(D) The incident heat energy estimated under subsection (a)(2) of this section exceeds 2.0 cal/cm^2.

(2) Arc rating. The employer shall ensure that each employee exposed to hazards from electric arcs wears protective clothing and other protective equipment with an arc rating greater than or equal to the heat energy estimated under subsection (a)(2) of this section whenever that estimate exceeds 2.0 cal/cm^2. This protective equipment shall cover the employee's entire body, except as follows:

(A) Arc-rated protection is not necessary for the employee's hands when the employee is wearing rubber insulating gloves with protectors or, if the estimated incident energy is no more than 14 cal/cm^2, heavy-duty leather work gloves with a weight of at least 407 gm/m^2 (12 oz/yd^2),

(B) Arc-rated protection is not necessary for the employee's feet when the employee is wearing heavy-duty work shoes or boots,

(C) Arc-rated protection is not necessary for the employee's head when the employee is wearing head protection meeting GISO, Section 3381 if the estimated

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incident energy is less than 9 cal/cm^2 for exposures involving single-phase arcs in open air or 5 cal/cm^2 for other exposures,

(D) The protection for the employee's head may consist of head protection meeting GISO, Section 3381 and a faceshield with a minimum arc rating of 8 cal/cm^2 if the estimated incident-energy exposure is less than 13 cal/cm^2 for exposures involving single-phase arcs in open air or 9 cal/cm^2 for other exposures, and

(E) For exposures involving single phase arcs in open air, the arc rating for the employee's head and face protection may be 4 cal/cm^2 less than the estimated incident energy.

(3) Dates.

(A) The requirement in subsection (a)(2) of this section for the employer to make reasonable estimates of incident energy commences **[OAL will insert this date to be six months from the effective date of the regulation]**.

(B) The requirement in subsection (a)(1)(D) of this section for the employer to ensure that the outer layer of clothing worn by an employee is flame-resistant when the estimated incident heat energy exceeds 2.0 cal/ cm^2 commences **[OAL will insert this date to be six months from the effective date of the regulation]**.

(C) The requirement in subsection (b)(2) of this section for the employer to ensure that each employee exposed to hazards from electric arcs wears the required arc-rated protective equipment commences **[OAL will insert this date to be six months from the effective date of the regulation]**.

(c) Fuse Handling. When an employee must install or remove fuses with one or both terminals energized at more than 300 volts, or with exposed parts energized at more than 50 volts, the employer shall ensure that the employee uses tools or gloves rated for the voltage. When an employee installs or removes expulsion-type fuses with one or both terminals energized at more than 300 volts, the employer shall ensure that the employee wears eye protection meeting the requirements of Section 3382, uses a tool rated for the voltage, and is clear of the exhaust path of the fuse barrel.

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(d) Covered (Noninsulated) Conductors. The requirements of this section that pertain to the hazards of exposed live parts also apply when an employee performs work in proximity to covered (noninsulated) wires.

(e) Non-Current-Carrying Metal Parts. Non-current-carrying metal parts of equipment or devices, such as transformer cases and circuit-breaker housings, shall be treated as energized at the highest voltage to which these parts are exposed, unless the employer inspects the installation and determines that these parts are grounded before employees begin performing the work.

(f) Opening and Closing Circuits Under Load. The employer shall ensure that devices used by employees to open circuits under load conditions are designed to interrupt the current involved and the devices used by employees to close circuits under load conditions are designed to safely carry the current involved.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Add new Section 2940.12 to read:

§2940.12. Making Connections.

(a) Making Connections. The employer shall ensure that employees make connections as follows:

(1) In connecting deenergized equipment or lines to an energized circuit by means of a conducting wire or device, an employee shall first attach the wire to the deenergized part;

(2) When disconnecting equipment or lines from an energized circuit by means of a conducting wire or device, an employee shall remove the source end first; and

(3) When lines or equipment are connected to or disconnected from energized circuits, an employee shall keep loose conductors away from exposed energized parts.

EXCEPTION to subsection (a): If conducting wire(s) or device(s) is/are secured by mechanical means to prevent accidental movement of conducting wires, the employer can determine the order of connection.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Add new Section 2940.13 to read:

§2940.13. Hazardous Energy Control Procedures.

(a) Application. The provisions of this section apply to the use of lockout/tagout procedures for the control of energy sources in installations for the purpose of electric power generation, including related equipment for communication or metering. Locking and tagging procedures for the deenergizing of electric energy sources which are used exclusively for purposes of transmission and distribution are addressed in Section 2940.14.

NOTE to subsection (a): Installations in electric power generation facilities that are not an integral part of, or inextricably commingled with, power generation processes or equipment are covered under Section 3314.

(b) General.

(1) The employer shall establish a program consisting of energy control procedures, employee training, and periodic inspections to ensure that, before any employee performs any servicing or maintenance on a machine or equipment where the unexpected energizing, start up, or release of stored energy could occur and cause injury, the machine or equipment is isolated from the energy source and rendered inoperative.

(2) The employer's energy control program shall meet the following requirements:

(A) If an energy isolating device is not capable of being locked out, the employer's program shall use a tagout system.

(B) If an energy isolating device is capable of being locked out, the employer's program shall use lockout, unless the employer can demonstrate that the use of a tagout system will provide full employee protection as follows:

1. When a tagout device is used on an energy isolating device which is capable of being locked out, the tagout device shall be attached at the same location that the lockout device would have been attached, and the employer shall demonstrate that the tagout program will provide a level of safety equivalent to that obtained by the use of a lockout program.

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2. In demonstrating that a level of safety is achieved in the tagout program equivalent to the level of safety obtained by the use of a lockout program, the employer shall demonstrate full compliance with all tagout-related provisions of this standard together with such additional elements as are necessary to provide the equivalent safety available from the use of a lockout device. Additional means to be considered as part of the demonstration of full employee protection shall include the implementation of additional safety measures such as the removal of an isolating circuit element, blocking of a controlling switch, opening of an extra disconnecting device, or the removal of a valve handle to reduce the likelihood of inadvertent energizing.

(C) Whenever replacement or major repair, renovation, or modification of a machine or equipment is performed, and whenever new machines or equipment are installed, energy isolating devices for such machines or equipment shall be designed to accept a lockout device.

(c) Hazardous Energy Control Procedures. Written procedures shall be developed, documented, and used for the control of potentially hazardous energy covered by subsection (a) of this section.

(1) The procedure shall clearly and specifically outline the scope, purpose, responsibility, authorization, rules, and techniques to be applied to the control of hazardous energy, and the measures to enforce compliance including, but not limited to, the following:

(A) A specific statement of the intended use of this procedure;

(B) Specific procedural steps for shutting down, isolating, blocking and securing machines or equipment to control hazardous energy;

(C) Specific procedural steps for the placement, removal, and transfer of lockout devices or tagout devices and the responsibility for them;

(D) Specific requirements for testing a machine or equipment to determine and verify the effectiveness of lockout devices, tagout devices, and other energy control measures; and

(E) The employer's hazardous energy control procedure shall include separate procedural steps for the safe lockout/tagout of each machine or piece of equipment affected by the hazardous energy control procedure.

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EXCEPTION to subsection(c)(1)(E): The procedural steps for the safe lockout/tagout of prime movers, machinery or equipment may be used for a group or type of machinery or equipment, when either of the following two conditions exist:

Condition 1:

A. The operational controls named in the procedural steps are configured in a similar manner, and

B. The locations of disconnect points (energy isolating devices) are identified, and

C. The sequence of steps to safely lockout or tagout the machinery or equipment are similar.

Condition 2: The machinery or equipment has a single energy supply that is readily identified and isolated and has no stored or residual hazardous energy.

(F) The employer shall conduct a periodic inspection of the energy control procedure at least annually to ensure that the procedure and the provisions of subsection (o) of this section are being followed.

(G) The employer shall provide training in accordance to subsection (p).

(d) Protective Materials and Hardware.

(1) Locks, tags, chains, wedges, key blocks, adapter pins, self-locking fasteners, or other hardware shall be provided by the employer for isolating, securing, or blocking of machines or equipment from energy sources.

(2) Lockout devices and tagout devices shall be singularly identified; shall be the only devices used for controlling energy; shall not be used for other purposes; and shall meet the following requirements:

(A) Lockout devices and tagout devices shall be capable of withstanding the environment to which they are exposed for the maximum period of time that exposure is expected.

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1. Tagout devices shall be constructed and printed so that exposure to weather conditions or wet and damp locations will not cause the tag to deteriorate or the message on the tag to become illegible.

2. Tagout devices shall be so constructed as not to deteriorate when used in corrosive environments.

(B) Lockout devices and tagout devices shall be standardized within the facility in at least one of the following criteria: color, shape, size. Additionally, in the case of tagout devices, print and format shall be standardized.

(C) Lockout devices shall be substantial enough to prevent removal without the use of excessive force or unusual techniques, such as with the use of bolt cutters or metal cutting tools.

(D) Tagout devices, including their means of attachment, shall be substantial enough to prevent inadvertent or accidental removal. Tagout device attachment means shall be of a non-reusable type, attachable by hand, self-locking, and nonreleasable with a minimum unlocking strength of no less than 50 pounds and shall have the general design and basic characteristics of being at least equivalent to a one-piece, all-environment-tolerant nylon cable tie.

(E) Each lockout device or tagout device shall include provisions for the identification of the employee applying the device.

(F) Tagout devices shall warn against hazardous conditions if the machine or equipment is energized and shall include a legend such as the following: Do Not Start, Do Not Open, Do Not Close, Do Not Energize, Do Not Operate.

(e) Energy Isolation. Lockout and tagout device application and removal shall only be performed by the authorized employees who are performing the servicing or maintenance.

(f) Notification. Affected employees shall be notified by the employer or authorized employee of the application and removal of lockout or tagout devices. Notification shall be given before the controls are applied and after they are removed from the machine or equipment.

NOTE to subsection (f): See also subsection (i) of this section, which requires that the second notification take place before the machine or equipment is reenergized.

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(g) Lockout/Tagout Application. The established procedures for the application of energy control (the lockout or tagout procedures) shall include the following elements and actions, and these procedures shall be performed in the following sequence:

(1) Before an authorized or affected employee turns off a machine or equipment, the authorized employee shall:

(A) Notify the affected employee(s) in accordance with subsection (f).

(B) Have knowledge of the type and magnitude of the energy, the hazards of the energy to be controlled, and the method or means to control the energy.

(2) The machine or equipment shall be turned off or shut down using the procedures established for the machine or equipment. An orderly shutdown shall be used to avoid any additional or increased hazards to employees as a result of the equipment stoppage.

(3) All energy isolating devices that are needed to control the energy to the machine or equipment shall be physically located and operated in such a manner as to isolate the machine or equipment from energy sources.

(4) Lockout or tagout devices shall be affixed to each energy isolating device by authorized employees.

(A) Lockout devices shall be attached in a manner that will hold the energy isolating devices in a "safe" or "off" position.

(B) Tagout devices shall be affixed in such a manner as will clearly indicate that the operation or movement of energy isolating devices from the "safe" or "off" position is prohibited.

1. Where tagout devices are used with energy isolating devices designed with the capability of being locked out, the tag attachment shall be fastened at the same point at which the lock would have been attached.

2. Where a tag cannot be affixed directly to the energy isolating device, the tag shall be located as close as safely possible to the device, in a position that will be immediately obvious to anyone attempting to operate the device.

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(5) Following the application of lockout or tagout devices to energy isolating devices, all potentially hazardous stored or residual energy shall be relieved, disconnected, restrained, or otherwise rendered safe.

(6) If there is a possibility of reaccumulation of stored energy to a hazardous level, verification of isolation shall be continued until the servicing or maintenance is completed or until the possibility of such accumulation no longer exists.

(h) Test. Before starting work on machines or equipment that have been locked out or tagged out, the authorized employee shall verify that isolation and deenergizing of the machine or equipment have been accomplished. If normally energized parts will be exposed to contact by an employee while the machine or equipment is deenergized, a test shall be performed to ensure that these parts are deenergized.

(i) Release From Lockout/Tagout. Before lockout or tagout devices are removed and energy is restored to the machine or equipment, procedures shall be followed and actions taken by the authorized employees to ensure the following:

(1) The work area shall be inspected to ensure that nonessential items have been removed and that machine or equipment components are operationally intact.

(2) The work area shall be checked to ensure that all employees have been safely positioned or removed.

(3) After lockout or tagout devices have been removed and before a machine or equipment is started, affected employees shall be notified that the lockout or tagout devices have been removed.

(4) Each lockout or tagout device shall be removed from each energy isolating device by the authorized employee who applied the lockout or tagout device. However, if that employee is not available to remove it, the device may be removed under the direction of the employer, provided that specific procedures and training for such removal have been developed, documented, and incorporated into the employer's energy control program. The employer shall demonstrate that the specific procedure provides a degree of safety equivalent to that provided by the removal of the device by the authorized employee who applied it. The specific procedure shall include at least the following elements:

(A) Verification by the employer that the authorized employee who applied the device is not at the facility;

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(B) Making all reasonable efforts to contact the authorized employee to inform him or her that his or her lockout or tagout device has been removed; and

(C) Ensuring that the authorized employee has this knowledge before he or she resumes work at that facility.

(j) Additional Requirements.

(1) If the lockout or tagout devices must be temporarily removed from energy isolating devices and the machine or equipment must be energized to test or position the machine, equipment, or component thereof, the following sequence of actions shall be followed:

(A) Clear the machine or equipment of tools and materials in accordance with subsection (i)(1) of this section;

(B) Remove employees from the machine or equipment area in accordance with subsections (i)(2) and (i)(3) of this section;

(C) Remove the lockout or tagout devices as specified in subsection (i)(4) of this section;

(D) Energize and proceed with the testing or positioning; and

(E) Deenergize all systems and reapply energy control measures in accordance with subsections (g) and (h) of this section to continue the servicing or maintenance.

(k) Group Lockout or Tagout. When servicing or maintenance is performed by a crew, craft, department, or other group, they shall use a procedure which affords the employees a level of protection equivalent to that provided by the implementation of a personal lockout or tagout device. Group lockout or tagout devices shall be used in accordance with the procedures required by subsection (c) of this section including, but not limited to, the following specific requirements:

(1) Primary responsibility shall be vested in an authorized employee for a set number of employees working under the protection of a group lockout or tagout device (such as an operations lock);

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(2) Provision shall be made for the authorized employee to ascertain the exposure status of all individual group members with regard to the lockout or tagout of the machine or equipment;

(3) When more than one crew, craft, department, or other group is involved, assignment of overall job-associated lockout or tagout control responsibility shall be given to an authorized employee designated to coordinate affected work forces and ensure continuity of protection; and

(4) Each authorized employee shall affix a personal lockout or tagout device to the group lockout device, group lockbox, or comparable mechanism when he or she begins work and shall remove those devices when he or she stops working on the machine or equipment being serviced or maintained.

(*l*) Shift or Personnel Changes. Procedures shall be used during shift or personnel changes to ensure the continuity of lockout or tagout protection, including provision for the orderly transfer of lockout or tagout device protection between off-going and on-coming employees, to minimize their exposure to hazards from the unexpected energizing or start-up of the machine or equipment or from the release of stored energy.

(m) Outside Servicing Personnel. Whenever outside servicing personnel are to be engaged in activities covered by subsection (a) of this section, the on-site employer and the outside employer shall inform each other of their respective lockout or tagout procedures, and each employer shall ensure that his or her personnel understand and comply with restrictions and prohibitions of the energy control procedures being used.

(n) System Operator. If energy isolating devices are installed in a central location and are under the exclusive control of a system operator, the following requirements apply:

(1) The employer shall use a procedure that affords employees a level of protection equivalent to that provided by the implementation of a personal lockout or tagout device.

(2) The system operator shall place and remove lockout and tagout devices in place of the authorized employee under subsections (e), (g)(4), and (i)(4) of this section.

(3) Provisions shall be made to identify the authorized employee who is responsible for (that is, being protected by) the lockout or tagout device, to transfer responsibility for lockout and tagout devices, and to ensure that an authorized employee requesting removal or transfer of a lockout or tagout device is the one responsible for it before the device is removed or transferred.

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(o) Periodic Inspections.

(1) The periodic inspection shall be performed by an authorized employee who is not using the energy control procedure being inspected

(2) The periodic inspection shall be designed to identify and correct any deviations or inadequacies.

(3) If lockout is used for energy control, the periodic inspection shall include a review, between the inspector and each authorized employee, of that employee's responsibilities under the energy control procedure being inspected.

(4) Where tagout is used for energy control, the periodic inspection shall include a review, between the inspector and each authorized and affected employee, of that employee's responsibilities under the energy control procedure being inspected, and the elements set forth in subsection (c)(1) of this section.

(5) The employer shall certify that the inspections required by this section have been accomplished. The certification shall identify the machine or equipment on which the energy control procedure was being used, the date of the inspection, the employees included in the inspection, and the person performing the inspection.

(p) Training. The employer shall provide training to ensure that the purpose and function of the energy control program are understood by employees and that the knowledge and skills required for the safe application, usage, and removal of energy controls are acquired by employees. The training shall include the following:

(1) Each authorized employee shall receive training in the recognition of applicable hazardous energy sources, the type and magnitude of energy available in the workplace, and in the methods and means necessary for energy isolation and control.

(2) Each affected employee shall be instructed in the purpose and use of the energy control procedure.

(3) All other employees whose work operations are or may be in an area where energy control procedures may be used shall be instructed about the procedures and about the prohibition relating to attempts to restart or reenergize machines or equipment that are locked out or tagged out.

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(4) When tagout systems are used, employees shall also be trained in the following limitations of tags:

(A) Tags are essentially warning devices affixed to energy isolating devices and do not provide the physical restraint on those devices that is provided by a lock.

(B) When a tag is attached to an energy isolating means, it is not to be removed without authorization of the authorized person responsible for it, and it is never to be bypassed, ignored, or otherwise defeated.

(C) Tags shall be legible and understandable by all authorized employees, affected employees, and all other employees whose work operations are or may be in the area, in order to be effective.

(D) Tags and their means of attachment shall be made of materials which will withstand the environmental conditions encountered in the workplace.

(E) Tags may evoke a false sense of security, and their meaning needs to be understood as part of the overall energy control program.

(F) Tags shall be securely attached to energy isolating devices so that they cannot be inadvertently or accidentally detached during use.

(5) Retraining shall be provided by the employer as follows:

(A) Retraining shall be provided for all authorized and affected employees whenever there is a change in their job assignments, a change in machines, equipment, or processes that present a new hazard or whenever there is a change in the energy control procedures.

(B) Retraining shall also be conducted whenever a periodic inspection under subsection (o) of this section reveals, or whenever the employer has reason to believe, that there are deviations from or inadequacies in an employee's knowledge or use of the energy control procedures.

(C) The retraining shall reestablish employee proficiency and shall introduce new or revised control methods and procedures, as necessary.

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(6) The employer shall certify that employee training has been accomplished and is being kept up to date. The certification shall contain each employee's name and dates of training.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Add new Section §2940.14 to read:

§2940.14. Deenergizing Lines and Equipment for Employee Protection.

(a) This section applies to the deenergizing of transmission and distribution lines and equipment for the purpose of protecting employees. See Section 2940.13 for requirements on the control of hazardous energy sources used in the generation of electric energy. Conductors and parts of electric equipment that have been deenergized under procedures other than those required by this Section shall be treated as energized.

(b) General.

(1) System operator. If a system operator is in charge of the lines or equipment and their means of disconnection, the employer shall designate one employee in the crew to be in charge of the clearance and shall comply with all of the requirements of subsection (c) of this section in the order specified.

(2) No system operator. If no system operator is in charge of the lines or equipment and their means of disconnection, the employer shall designate one employee in the crew to be in charge of the clearance and to perform the functions that the system operator would otherwise perform under this section. All of the requirements of subsection (c) apply, in the order specified, except as provided in subsection (b)(3) of this section.

(3) Single crew. If only one crew will be working on the lines or equipment and if the means of disconnection is accessible and visible to, and under the sole control of, the employee in charge of the clearance, subsections (c)(1), (c)(3), and (c)(5) of this section do not apply. Additionally, the employer does not need to use the tags required by the remaining provisions of subsection (c).

(4) Multiple crews. If two or more crews will be working on the same lines or equipment, then:

(A) The crews shall coordinate their activities under this section with a single employee in charge of the clearance for all of the crews and follow the requirements of this section as if all of the employees formed a single crew, or

(B) Each crew shall independently comply with this section and, if there is no system operator in charge of the lines or equipment, shall have separate tags and coordinate deenergizing and reenergizing the lines and equipment with the other crews.

(5) Disconnecting means accessible to general public. The employer shall render any disconnecting means that are accessible to individuals outside the employer's control (for example, the general public) inoperable while the disconnecting means are open for the purpose of protecting employees.

(c) Deenergizing Lines and Equipment.

(1) Request to deenergize. The employee that the employer designates pursuant to subsection (b) of this section as being in charge of the clearance shall make a request of the system operator to deenergize the particular section of line or equipment. The designated employee becomes the employee in charge (as this term is used in subsection (c) of this section) and is responsible for the clearance.

(2) Open disconnecting means. The employer shall ensure that all switches, disconnectors, jumpers, taps, and other means through which known sources of electric energy may be supplied to the particular lines and equipment to be deenergized are open. The employer shall render such means inoperable, unless its design does not so permit, and then ensure that such means are tagged to indicate that employees are at work.

(3) Automatically and remotely controlled switches. The employer shall ensure that automatically and remotely controlled switches that could cause the opened disconnecting means to close are also tagged at the points of control. The employer shall render the automatic or remote control feature inoperable, unless its design does not so permit.

(4) Network protectors. The employer need not use the tags mentioned in subsections (c)(2) and (c)(3) of this section on a network protector for work on the primary feeder for the network protector's associated network transformer when the employer can demonstrate all of the following conditions:

(A) Every network protector is maintained so that it will immediately trip open if closed when a primary conductor is deenergized;

(B) Employees cannot manually place any network protector in a closed position without the use of tools, and any manual override position is blocked, locked, or otherwise disabled; and

(C) The employer has procedures for manually overriding any network protector that incorporate provisions for determining, before anyone places a network protector in a closed position, that: The line connected to the network protector is not deenergized for the protection of any employee working on the line; and (if the line connected to the network protector is not deenergized for the protection of any employee working on the line) the primary conductors for the network protector are energized.

(5) Tags. Tags shall prohibit operation of the disconnecting means and shall indicate that employees are at work.

(6) Test for energized condition. After the applicable requirements in subsections (c)(1) through (c)(5) of this section have been followed and the system operator gives a clearance to the employee in charge, the employer shall ensure that the lines and equipment are deenergized by testing the lines and equipment to be worked with a device designed to detect voltage.

(7) Install grounds. The employer shall ensure the installation of protective grounds as required by Section 2940.15.

(8) After the applicable requirements of subsections (c)(1) through (c)(7) of this section have been followed, the lines and equipment involved may be considered deenergized.

(d) Transfer Clearance. To transfer the clearance, the employee in charge (or the employee's supervisor if the employee in charge must leave the worksite due to illness or other emergency) shall inform the system operator and employees in the crew; and the new employee in charge shall be responsible for the clearance.

(e) Releasing Clearances. To release a clearance, the employee in charge shall:

(1) Notify each employee under that clearance of the pending release of the clearance;

(2) Ensure that all employees under that clearance are clear of the lines and equipment;

(3) Ensure that all protective grounds protecting employees under that clearance have been removed; and

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(4) Report this information to the system operator and then release the clearance. clearance.

(f) Person Releasing Clearance. Only the employee in charge who requested the clearance can release the clearance, unless the employer transfers responsibility under subsection (d) of this section.

(g) Removal of Tags. No one shall remove tags without the release of the associated clearance as specified under subsections (e) and (f) of this section.

(h) Reenergizing Lines and Equipment. The employer shall ensure that no one initiates action to reenergize the lines or equipment at a point of disconnection until all protective grounds have been removed, all crews working on the lines or equipment release their clearances, all employees are clear of the lines and equipment, and all protective tags are removed from that point of disconnection.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 36. Work Procedures and Operating Procedures

Add new Section 2940.15 to read:

§2940.15. Grounding For the Protection of Employees.

(a) Application. This section applies to grounding of transmission, and distribution lines and equipment for the purpose of protecting employees. Subsection (f) of this section also applies to protective grounding of other equipment as required elsewhere in this Article.

(b) General. For any employee to work transmission and distribution lines or equipment as deenergized, the employer shall ensure that the lines or equipment are deenergized under the provisions of Section 2940.14 and shall ensure proper grounding of the lines or equipment as specified in subsections (c) through (i) of this section. However, if the employer can demonstrate that installation of a ground is impracticable or that the conditions resulting from the installation of a ground would present greater hazards to employees than working without grounds, the lines and equipment may be treated as deenergized provided that the employer establishes that all of the following conditions apply:

(1) The employer ensures that the lines and equipment are deenergized under the provisions of Section 2940.14.

(2) There is no possibility of contact with another energized source.

(3) The hazard of induced voltage is not present.

(c) Testing. Tests shall be conducted to insure that conductors or equipment have been deenergized before employees install any ground on lines or equipment.

(d) Guards or barriers shall be installed as necessary to prevent contact with another exposed energized conductor or equipment.

(e) Equipotential Zone. Temporary protective grounds shall be placed at such locations and arranged in such a manner that the employer can demonstrate will prevent each employee from being exposed to hazardous differences in electric potential.

NOTE to subsection (e): Appendix E to this Article contains guidelines for establishing the equipotential zone required by this subsection. The Division of Occupational Safety and Health

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will deem grounding practices meeting these guidelines as complying with subsection (e) of this section.

(f) Protective Grounding Equipment.

(1) Conductor(s) or equipment to be grounded shall be clearly identified and isolated from all sources of voltage.

(2) Protective grounding equipment shall be capable of conducting the maximum anticipated fault current.

(3) Grounding devices shall have a minimum conductance of No. 2 AWG copper.

(4) Protective grounds shall have an impedance low enough so that they do not delay the operation of protective devices in case of accidental energizing of the lines or equipment.

(5) There shall be a minimum of one ground on the conductors or equipment being worked on:

(A) between the place where the work is being done and each possible source of supply,

(B) at the work location, or

(C) as close as practicable to the source of supply.

(6) One of the grounding devices shall be visible to at least one member of the crew unless one of the grounding devices is accessible only to authorized persons.

NOTE to subsection (f): Guidelines for protective grounding equipment are contained in American Society for Testing and Materials Standard Specifications for Temporary Grounding Systems to be Used on De-Energized Electric Power Lines and Equipment, ASTM F 855-09. Guidelines for selecting and installing protective grounding equipment are contained in The Institute of Electrical Engineers Guide for Protective Grounding of Power Lines, IEEE Std 1048–2003.

(g) Connecting and Removing Grounds.

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(1) Order of connection. The employer shall ensure that, when an employee attaches a ground to a line or to equipment, the employee attaches the ground-end connection first and then attaches the other end by means of a live-line tool.

(2) Order of removal. The employer shall ensure that, when an employee removes a ground, the employee removes the grounding device from the line or equipment using a live-line tool before he or she removes the ground-end connection.

(h) Additional Precautions. The employer shall ensure that, when an employee performs work on a cable at a location remote from the cable terminal, the cable is not grounded at the cable terminal if there is a possibility of hazardous transfer of potential should a fault occur.

(i) Removal of Grounds for Test. The employer may permit employees to remove grounds temporarily during tests. During the test procedure, the employer shall ensure that each employee uses insulating equipment, shall isolate each employee from any hazards involved, and shall implement any additional measures necessary to protect each exposed employee in case the previously grounded lines and equipment become energized.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 36. Work Procedures and Operating Procedures

Add new Section 2940.16 to read:

§2940.16. Testing and Test Facilities.

(a) Application. This section provides for safe work practices for high-voltage and high-power testing performed in laboratories, shops, and substations, and in the field and on electric transmission and distribution lines and equipment. It applies only to testing involving interim measurements using high voltage, high power, or combinations of high voltage and high power, and not to testing involving continuous measurements as in routine metering, relaying, and normal line work.

EXCEPTION to subsection (a): For the purposes of this section, routine inspection and maintenance measurements made by qualified employees shall be considered to be routine line work not included in the scope of this section, provided that the hazards related to the use of intrinsic high-voltage or high-power sources require only the normal precautions associated with routine work specified in the other sections of the High-Voltage Electrical Safety Orders. Two typical examples of such excluded test work procedures are ‘‘phasing-out’’ testing and testing for a ‘‘no-voltage’’ condition.

(b) General Requirements.

(1) Safe work practices. The employer shall establish and enforce work practices for the protection of each worker from the hazards of high-voltage or high-power testing at all test areas, temporary and permanent. Such work practices shall include, at a minimum, test area safeguarding, grounding, the safe use of measuring and control circuits, and a means providing for periodic safety checks of field test areas.

(2) Training. The employer shall ensure that each employee, upon initial assignment to the test area, receives training in safe work practices, with retraining provided in accordance with Section 2940 of these Orders and Section 3203 of the General Industry Safety Orders.

(c) Safeguarding of Test Areas.

(1) The employer shall provide safeguarding within test areas to control access to test equipment or to apparatus under test that could become energized as part of the testing by

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either direct or inductive coupling and to prevent accidental employee contact with energized parts.

(2) Permanent test areas. The employer shall guard test areas with walls, fences, or other barriers to keep employees out of test areas.

(3) Temporary test areas. In field testing, or at a temporary test site not guarded by permanent fences and gates, the employer shall ensure the use of one of the following means to prevent employees without authorization from entering:

(A) Distinctively colored safety tape supported approximately waist high with safety signs attached to it,

(B) A barrier or barricade that limits access to the test area to a degree equivalent, physically and visually, to the barricade specified in subsection (c)(3)(A) of this section, or

(C) One or more test observers stationed so that they can monitor the entire area.

(4) Removal of safeguards. The employer shall ensure the removal of the safeguards required by subsection (c)(3) of this section when employees no longer need the protection afforded by the safeguards.

(d) Grounding Practices.

(1) Establish and implement practices. The employer shall establish and implement safe grounding practices for the test facility.

(A) The employer shall maintain at ground potential all conductive parts accessible to the test operator while the equipment is operating at high voltage.

(B) Wherever ungrounded terminals of test equipment or apparatus under test may be present, they shall be treated as energized until tests demonstrate that they are deenergized.

(2) Installation of grounds. The employer shall ensure either that visible grounds are applied automatically, or that employees using properly insulated tools manually apply visible grounds, to the high-voltage circuits after they are deenergized and before any employee performs work on the circuit or on the item or apparatus under test. Common

ground connections shall be solidly connected to the test equipment and the apparatus under test.

(3) Isolated ground return. In high-power testing, the employer shall provide an isolated ground-return conductor system designed to prevent the intentional passage of current, with its attendant voltage rise, from occurring in the ground grid or in the earth. However, the employer need not provide an isolated ground-return conductor if the employer can demonstrate that both of the following conditions exist:

(A) The employer cannot provide an isolated ground-return conductor due to the distance of the test site from the electric energy source, and

(B) The employer protects employees from any hazardous step and touch potentials that may develop during the test.

NOTE to subsection (d)(3)(B): See Appendix E for information on measures that employers can take to protect employees from hazardous step and touch potentials.

(4) Equipment grounding conductors. For tests in which using the equipment grounding conductor in the equipment power cord to ground the test equipment would result in greater hazards to test personnel or prevent the taking of satisfactory measurements, the employer may use a ground clearly indicated in the test set-up if the employer can demonstrate that this ground affords protection for employees equivalent to the protection afforded by an equipment grounding conductor in the power supply cord.

(5) Grounding after tests. The employer shall ensure that, when any employee enters the test area after equipment is deenergized, a ground is placed on the high-voltage terminal and any other exposed terminals.

(A) Before any employee applies a direct ground, the employer shall discharge high capacitance equipment through a resistor rated for the available energy.

(B) A direct ground shall be applied to the exposed terminals after the stored energy drops to a level at which it is safe to do so.

(6) Grounding test vehicles. If the employer uses a test trailer or test vehicle in field testing, its chassis shall be grounded. The employer shall protect each employee against hazardous touch potentials with respect to the vehicle, instrument panels, and other conductive parts accessible to employees with bonding, insulation, or isolation.

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(e) Control and Measuring Circuits.

(1) Control wiring. The employer shall not run control wiring, meter connections, test leads, or cables from a test area unless contained in a grounded metallic sheath and terminated in a grounded metallic enclosure or unless the employer takes other precautions that it can demonstrate will provide employees with equivalent safety.

(2) Instruments. The employer shall isolate meters and other instruments with accessible terminals or parts from test personnel to protect against hazards that could arise should such terminals and parts become energized during testing. If the employer provides this isolation by locating test equipment in metal compartments with viewing windows, the employer shall provide interlocks to interrupt the power supply when someone opens the compartment cover.

(3) Routing of temporary wires. The employer shall protect temporary wiring and its connections against damage, accidental interruptions, and other hazards. To the maximum extent possible, the employer shall keep signal, control, ground, and power cables separate from each other.

(4) Test observer. If any employee will be present in the test area during testing, a test observer shall be present. The test observer shall be capable of implementing the immediate deenergizing of test circuits for safety purposes.

(f) Safety Check.

(1) Before each test. Safety practices governing employee work at temporary or field test areas shall provide, at the beginning of each series of tests, for a routine safety check of such test areas.

(2) Conditions to be checked. The test operator in charge shall conduct these routine safety checks before each series of tests and shall verify at least the following conditions:

(A) Barriers and safeguards are in workable condition and placed properly to isolate hazardous areas;

(B) System test status signals, if used, are in operable condition;

(C) Clearly marked test-power disconnects are readily available in an emergency;

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(D) Ground connections are clearly identifiable;

(E) Personal protective equipment is provided and used as required by Article 10 of the GISO and by Section 2940.06, Section 2940.11, and this section; and

(F) Proper separation between signal, ground, and power cables.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 36. Work Procedures and Operating Procedures

Amend Section 2941 to read:

§2941. Work on or in Proximity to Overhead High Voltage Lines.

*****

(f) Working on Conductors or Equipment Energized at 600 Volts or More.

(1) Employees shall not be permitted to touch or work on exposed energized conductors or equipment except when wearing suitable insulating gloves with protectors, or when using other suitable devices. Only rubber <u>insulating</u> gloves <u>in accordance with Section 2940.6</u> ~~labeled as being manufactured and tested to meet ASTM D120-95, Standard Specification for Rubber Insulating Gloves~~, for the potential voltage exposure shall be used. Rubber gloves shall not be considered suitable devices when working on conductors or equipment energized in excess of 21,000 volts.

*****

(h) Grounding De-Energized Conductors or Equipment. Any exposed ungrounded conductors or equipment not worked upon in accordance with the provisions of subsection~~s~~ (f) above, shall not be worked upon until the ~~following~~ provisions <u>in Section 2940.15</u> are complied with<u>.</u>~~:~~

~~(1) Conductors or equipment to be grounded are clearly identified and isolated from all sources of voltage.~~

~~(2) Notification has been obtained from the designated employee that all switches or other points of isolation through which electric energy may be supplied to the conductors or equipment to be worked on have been opened and are plainly tagged indicating that employees are at work, and where the design permits, they have been rendered inoperable.~~

~~(3) When more than one independent crew requires the same conductors or equipment to be de-energized, a tag for each such independent crew has been placed at the switch(s)or other point(s) of isolation, except that where clearances for such independent crews are controlled by a designated authority having immediate jurisdiction over the conductors or equipment involved, only one tag need be installed at each switch or point of isolation.~~

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~~(4) A test has been conducted to insure that conductors or equipment have been de-energized.~~

~~(5) The conductors or equipment shall be grounded and short-circuited.~~

~~(6) Suitable grounding devices shall be used. They shall be first connected to a ground before being brought into contact with any de-energized conductor or equipment to be grounded. The other end shall be attached and removed by means of insulated tools or other suitable devices. When removed they shall be removed from all circuit conductors or equipment before being disconnected from ground.~~

~~(7) There shall be a minimum of one ground on the conductors or equipment being worked on:~~

~~(A) between the place where the work is being done and each possible source of supply, or~~

~~(B) at each work location.~~

~~(8) One of the grounding devices shall be visible to at least one member of the crew unless one of the grounding devices has all of its component parts at least 15 feet above ground level to prevent tampering.~~

~~(9) Grounds shall be permitted to be temporarily removed for test purposes and extreme caution shall be exercised during test procedures.~~

~~(10) Grounding devices shall be capable of conducting the anticipated fault current and shall have a minimum conductance of No. 2 AWG copper.~~

~~NOTE: Guidelines for protective grounding equipment are contained in American Society for Testing and Materials Standard Specifications for Temporary Grounding Systems to be Used on De-energized Electric Power Lines and Equipment, ASTM F 855-97.~~

~~(11) Temporary protective grounds shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to hazardous differences in electrical potential.~~

~~(12) Upon completion of work on grounded conductors or equipment, the employee in charge of each independent crew shall determine that all employees in the crew are clear,~~

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~~and shall report to the designated authority that all tags protecting the crew may be removed. Prior to the energizing of the conductors or equipment, the employer shall ascertain that all employees are clear and all grounds are removed.~~

(i) Stringing or Removing Conductors.

(1) General.

*****

(H) Rigging.

1. The rated capacity of catch-off anchors, rigging, and hoists shall not be exceeded.

2. The design load rating shall not be exceeded for the stringing lines, pulling lines, sock connections, and all load-bearing hardware and accessories.

3. Pulling lines and accessories shall be inspected regularly and replaced or repaired when damaged.

*****

(J) While the conductor or pulling line is in motion:

1. employees on wood poles shall not be permitted to be on the crossarm,

2. employees on steel structures shall not be permitted to be on the crossarm except as necessary to install the conductor or pulling line into the stringing sheaves and

3. employees on the ground shall not be permitted directly under the conductor or pulling line in motion except as necessary for the employees to guide the stringing sock or board over or through the stringing sheave ~~to perform work directly related to the stringing operation~~.

*****

(L) 1. Reel handling equipment, including pulling and braking machines, shall

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have ample capacity, operate smoothly, and be leveled and aligned in accordance with the manufacturer's operating instruction.

2. Suitable communications between the reel tender and pulling rig operator shall be provided.

3. Each pull shall be snubbed or dead ended at both ends before subsequent pulls are made.

4. Employees shall operate the pulling rig only when it is safe to do so.

(2) Adjacent to Energized High Voltage Lines.

(A) Prior to stringing or removing conductors adjacent to an existing energized overhead high voltage line a determination shall be made to ascertain whether hazardous induced voltage buildups will occur. When it has been determined that such hazardous induced voltages may exist, the employer shall comply with the following provisions (B through ~~I~~J) unless the line is worked as energized.

(B) The tension stringing method or other methods which preclude unintentional contact between the lines being pulled and any employee shall be used.

(C) All pulling and tensioning equipment shall be grounded or shall be considered as energized and shall be barricaded, isolated or insulated.

(D) Temporary protective grounds shall be placed at such locations and arranged in such a manner that the employer can demonstrate will prevent exposure of each employee to hazardous differences in electric potential.

NOTE to subsection (i)(2)(D): Appendix E contains guidelines for protecting employees from hazardous differences in electric potential as required by this subsection.

~~(D)~~(E) A ground shall be installed between the tensioning reel setup and the first structure in order to ground each bare conductor, subconductor, and overhead ground conductor during stringing operations.

~~(E)~~(F) Each bare conductor, subconductor, and overhead ground conductor shall be grounded at the first tower adjacent to both the tensioning and pulling setup and in increments so that no point is more than 2 miles from a ground.

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1. The grounds shall be left in place until conductor installation is completed.

2. Such grounds shall be removed as the last phase of aerial cleanup.

3. Except for traveling type grounds, the grounds shall be placed and removed by use of a non-conductive means.

~~(F)~~(G) Conductors, subconductors, and overhead ground conductors shall be grounded at all dead-end or catch-off points.

~~(G)~~(H) A ground shall be located at each side and within 10 feet of working areas where conductors, subconductors, or overhead ground conductors are being spliced at ground level. The two ends to be spliced shall be bonded to each other.

~~(H)~~(I) The conductors, subconductors, and overhead ground conductors being worked on shall be bonded to the tower.

~~(I)~~(J) Employees standing on the ground shall not be permitted to contact equipment or machinery working near energized lines or equipment unless the employee is using suitable protective equipment for the voltage involved.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 36. Work Procedures and Operating Procedures

Amend Section 2941.1 to read:

§2941.1. Metal Tower Construction.

*****

(d) When assembling and erecting towers, the provisions of subsections (d)(1), (d)(2) and (d)(3) following shall be complied with~~.~~:

(1) The construction of transmission towers and the erecting of poles, hoisting machinery, site preparation machinery, and other types of construction machinery shall conform to the applicable requirements of this article.

(2) No one shall be permitted under a tower or structure which is in the process of erection or assembly, except as may be required to guide and secure the section being set.

(3) When erecting towers using hoisting equipment adjacent to energized transmission lines, the minimum clearance distances required by Section ~~2940.2(b), Table 2940.2~~ 2940.2 shall be maintained.

(e) (1) Erection cranes shall be set on a firm foundation and when the cranes are so equipped, outriggers shall be used.

(2) Tag lines shall be utilized to maintain control of tower sections being raised and positioned, unless the employer can demonstrate that the use of tag lines would create a greater hazard to employees.

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NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 36. Work Procedures and Operating Procedures

Amend Section 2943 to read:

§2943. Work on or in Proximity to Underground High-Voltage Cables, Conductors or Equipment.

*****

(b) Manholes, Vaults, or Similar Structures.

(1) The employer shall ~~comply with~~ ~~the confined space requirements of General Industry Safety Orders Article 108 .~~ determine if entry into the space is under Section 2943.1 for Enclosed Spaces or the permit required confined space under Article 108 of the General Industry or Article 37 of the Construction Safety Orders and shall comply with the appropriate safety orders.

(2) The employer shall ensure that employees use a ladder or other climbing device to enter and exit a manhole or subsurface vault exceeding 4 feet (1.22 meters) in depth. The employee shall not climb into or out of a manhole or vault by stepping on cables or hangers.

~~(2)~~(3) Whenever the cover is removed from a manhole, vault, or similar structure:

(A) A~~a~~n employee shall be stationed at the surface as long as workers are in the structure, and

(B) warning devices shall be placed so as to warn vehicular or pedestrian traffic and shall not be removed until the cover is in place.

(4) Attendants for manholes and vaults. While work is being performed in a manhole or vault containing energized electric equipment, an employee with first-aid training shall be available on the surface in the immediate vicinity of the manhole or vault entrance to render emergency assistance.

(5) If entry is by Section 2943.1, the employee on the surface may enter a manhole or vault briefly to provide nonemergency assistance.

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(6) If entry is by Section 2943.1 for the purpose of inspection, housekeeping, taking readings, or similar work, an employee working alone may enter, for brief periods of time, a manhole or vault where energized cables or equipment are in service if the employer can demonstrate that the employee will be protected from all electrical hazards.

(7) Communications. The employer shall ensure that employees maintain reliable communications, through two way radios or other equivalent means, among all employees involved in the job.

(8) Hoisting equipment. Equipment used to lower materials and tools into manholes or vaults shall be capable of supporting the weight to be lowered and shall be checked for defects before use.

(9) Clear the area of employees. Before anyone lowers tools or material into the opening for a manhole or vault, each employee working in the manhole or vault shall be clear of the area directly under the opening.

~~(3)~~(10) When employees are working in an underground structure, the automatic circuit recloser on the circuit being worked shall be made non-automatic when:

(A) operating energized oil type switches from inside the structure,

(B) splicing energized underground cable,

(C) patching energized lead cable,

(D) relocating energized underground cable or equipment other than minor cable movements for additional clearance or routine maintenance such as cleaning cable, fire-proofing, replacing cable support blocks, etc.,

(E) filtering or replacing oil in energized underground equipment, or

(F) the supervisor in charge deems it necessary for the safety of the employees performing the work.

~~(4)~~(11) When employees are in an underground structure where newly installed, rebuilt or modified cable or equipment is being energized for the first time, the automatic circuit recloser on the circuit involved shall be made non-automatic.

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(12) Sheath continuity. When employees perform work on buried cable or on cable in a manhole or vault, the employer shall maintain metallic-sheath continuity, or the cable sheath shall be treated as energized.

(c) Trenching and Excavating.

(1) Trenching and excavation operations shall comply with the applicable provisions of the Construction Safety Orders.

(2) Where cable(s) exist in an excavation, such cable(s) shall be protected from physical damage during excavation.

(d) Duct Rods. The employer shall ensure that, if employees use duct rods, the employees install the duct rods in the direction presenting the least hazard to employees. The employer shall station an employee at the far end of the duct line being rodded to ensure that the employees maintain the required minimum approach distances.

(e) Multiple Cables. When multiple cables are present in a work area, the employer shall identify the cable to be worked by electrical means, unless its identity is obvious by reason of distinctive appearance or location or by other readily apparent means of identification. The employer shall protect cables other than the one being worked from damage.

(f) Moving Cables. The employer shall ensure that employees inspect energized cables to be moved for abnormalities.

EXCEPTION: When subsection (g)(2) of this section permits employees to perform work that could cause a fault, the employee shall be protected from possible effects of failure using shields or other devices capable of containing the adverse effect of the fault.

(g) Protection Against Faults.

(1) Cables with abnormalities. Where a cable in a manhole or vault has one or more abnormalities that could lead to a fault or be an indication of an impending fault, the employer shall deenergize the cable with the abnormality before any employee may work in the manhole or vault.

(A) The employer shall treat the following abnormalities as indications of impending faults unless the employer can demonstrate that the following conditions could not lead to a fault:

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1. oil or compound leaking from cable or joints,

2. broken cable sheaths or joint sleeves,

3. hot localized surface temperatures of cables or joints, or

4. joints swollen beyond normal tolerance.

EXCEPTION to subsection (g)(1): When service-load conditions and a lack of feasible alternatives require that the cable remain energized. In that case, employees may enter the manhole or vault provided the employer protects them from the possible effects of a failure using shields or other devices that are capable of containing the adverse effects of a fault.

(2) Work-related faults. If the work employees will perform in a manhole or vault could cause a fault in a cable, the employer shall deenergize that cable before any employee works in the manhole or vault.

NOTES to subsection (g)(2):

The following are not considered work that could cause a fault:

1. The chipping or slicing is performed with the use of hand tools, such as hammer and cold chisel, with movements that could potentially penetrate the cable directed away from the cable or limited by use of tool guard to prevent contact with the cable, and nonconductive barrier is inserted (if practicable) to protect the cable from penetration once sufficient material has been broken to make that action possible, or

2. Chipping of slicing performed with power tools using the following procedures: power tools are operated in a direction away from the energized cable unless tool guard are used to prevent contact with the cable; power tool are not used within 0.5 inch of an energized cable unless tool guards to prevent contact with energized cable are used; and a non conductive protective barrier is inserted (if practicable) to protect the cable from penetration once sufficient material has been broken to make the action possible.

EXCEPTION to subsection (g)(2): When service load conditions and a lack of feasible alternatives require that the cable remain energized. In that case, employees may enter the manhole or vault provided the employer protects them from the possible effects of a

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failure using shields or other devices that are capable of containing the adverse effects of a fault.

~~(d)~~(h) Working on Cables, Conductors or Equipment Energized at 7,500 Volts or Less.

(1) Employees shall not be permitted to cut, splice, or move cables energized at 7,500 volts or less without first obtaining permission from the employee in charge.

(2) Before cutting into a cable or opening a splice, the cable shall be identified and verified to be the proper cable.

(3) Suitable rubber gloves with protectors and protective clothing in accordance with Section 2940.11 shall be worn when working on exposed conductors or equipment energized at 7,500 volts or less. Other exposed energized or grounded conductors or equipment in the work area, with which contact can be readily made, shall be covered with adequate protective devices, barricaded or otherwise isolated.

(4) Before breaking the electrical continuity of metallic sheaths of cables energized at 7,500 volts or less, both sides of the break shall be bonded together across the break.

(5) When working on exposed underground conductors or parts of equipment energized at 7,500 volts or less, adequate barriers or suitable protective covering shall be provided if a working space of 36 inches cannot be obtained.

~~(e)~~(i) Working on Cables, Conductors or Equipment Energized in Excess of 7,500 Volts.

(1) When working on cables, conductors or equipment energized in excess of 7,500 volts, all exposed energized cables, conductors or equipment within reach of any part of the body shall be covered with suitable protective equipment in accordance with Sections 2940.6 and 2940.11 or barricaded.

(2) The only work permitted on cables, conductors or equipment energized in excess of 7,500 volts shall be:

(A) replacing fuses, operating switches, or other operations that do not require the employee to contact energized conductors or parts of equipment with any part of the employee's body,

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(B) working on the exterior of such cables or equipment, provided all current-carrying parts are effectively covered by grounded shielding or metallic enclosures, and

(C) work in the high voltage compartment of padmounted transformers and similar equipment installed above ground, provided the work is done by suitable devices. Rubber gloves shall not be considered to be suitable devices.

(3) Cables energized in excess of 7,500 volts shall be moved only under the direction of the employee in charge. Before moving cables, they shall be examined for any defects, which might result in failure if the cable were moved.

~~(f)~~(j) Working on De-Energized Cables, Conductors or Equipment.

(1) De-energize cables, conductors, or equipment in accordance with the procedures in Section 2940.14 and Section 2940.15.

~~(1)~~(2) When working on de-energized cables, conductors or equipment, all exposed energized conductors or equipment within reach of any part of the body, shall be covered with suitable protective equipment in accordance with Sections 2940.6 and 2940.11.

~~(2)~~(3) Where more than one cable exists in an excavation, cables other than the one being worked on shall be physically protected as necessary.

~~(3)~~(4) Where more than one cable exists in an excavation, the cable to be worked on shall be identified by electrical means or spiking unless its identity is obvious.

~~(4)~~(5) Before cutting into a cable or opening a splice, the cable shall be identified and verified to be the proper cable.

~~(g)~~(k) Grounding De-Energized Conductors or Equipment. ~~(1)~~ Any exposed ungrounded part of conductors or equipment, not worked upon in accordance with the provisions of subsections ~~(d)~~ (h) or ~~(e)~~ (i) above, shall not be worked upon until the ~~following~~ provisions in Sections 2940.14 and 2940.15 have been complied with.

~~(A) Conductor(s) or equipment to be grounded are clearly identified and isolated from all sources of voltage.~~

~~(B) Notification has been obtained from the designated employee that all switches or other points of isolation through which electric energy may be supplied to the~~

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~~conductors or equipment to be worked on have been opened and are plainly tagged indicating that employees are at work, and where the design permits, they have been rendered inoperable.~~

~~(C) Visual inspection or tests are made to insure that cable(s), conductor(s) or equipment have been de-energized.~~

~~(D) Guards or barriers are installed as necessary to prevent contact with exposed energized conductors or equipment.~~

~~(E) Grounds are applied except where their installation or use increases the working hazard. Grounds shall be permitted to be removed for test purposes.~~

~~(F) Suitable grounding devices shall be used. They shall be first connected to a ground before being brought into contact with any de-energized conductors or equipment to be grounded. The other end shall be attached and removed by means of insulated tools or other suitable devices. When removed, they shall be removed from all conductors or equipment before being disconnected from ground.~~

~~(G) When required, there shall be a minimum of one ground on the conductors or equipment being worked on:~~

~~1. between the place where the work is being done and each possible source of supply,~~

~~2. at the work location, or~~

~~3. as close as practicable to the source of supply.~~

~~(H) One of the grounding devices shall be visible to at least one member of the crew unless one of the grounding devices is accessible only to authorized persons.~~

~~(I) Grounding devices shall be capable of conducting the anticipated fault current and shall have a minimum conductance of No. 2 AWG copper.~~

~~(J) When more than one independent crew requires the same cable(s), conductor(s) or equipment to be de-energized, a tag for each such independent crew shall be placed on the cable(s), conductor(s) or equipment. Where clearances for such independent crews are controlled by a designated authority having~~

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~~immediate jurisdiction over the cable(s), conductor(s) or equipment involved only one tag need be installed.~~

~~(4) Upon completion of work the employee in charge of each independent crew shall determine that all employees in the crew are clear, and shall report to the designated authority that all tags protecting the crew may be removed.~~

~~(3) Prior to the energizing of the cable(s) or equipment, the employer shall ascertain that all employees are clear and all grounds are removed.~~

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 36. Work Procedures and Operating Procedures

Add new Section 2943.1 to read:

§2943.1. Enclosed Spaces.

Enclosed space. A working space, such as a manhole, vault, tunnel, or shaft, that has a limited means of egress or entry, that is designed for periodic employee entry under normal operating conditions, and that, under normal conditions, does not contain a hazardous atmosphere, but may contain a hazardous atmosphere under abnormal conditions.

(a) General. This section covers enclosed spaces that may be entered by employees. It does not apply to vented vaults if the employer makes a determination that the ventilation system is operating to protect employees before they enter the space.

This section applies to routine entry into enclosed spaces. If, after the employer takes the precautions given in this section and in Section 2943, the hazards remaining in the enclosed space endanger the life of an entrant or could interfere with an entrant's escape from the space, then entry into the enclosed space shall meet the permit space entry requirements of Article 37 of the Construction Safety Orders or Section 5157 of the General Industry Safety Orders.

NOTE to subsection (a): Entries into enclosed spaces conducted in accordance with the permit space entry requirements of Article 37 of the Construction Safety Orders or Section 5157 of the General Industry Safety Orders are considered as complying with this section.

(b) Safe Work Practices.

(1) Written, understandable safe work practices for entry into, and work in enclosed spaces and for rescue procedures shall be developed, implemented, and provided to affected employees.

(2) Safe work practices shall conform to the applicable requirements of this section and shall include provision for the surveillance of the surrounding area to avoid hazards such as drifting vapors from tanks, piping and sewers.

(3) For multi-employer worksites, the procedures shall address how all the affected employers will coordinate their work activities, so that operations of one employer will not endanger the employees of any other employer. If the permit-required confined space

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requirements of Section 5157 or Article 37 of the CSO or the requirements of Section 8355 apply to one or more of the other employers, then the procedures shall also include coordination with those employers.

(c) Training. Employees, including attendants, shall be trained in the nature of the hazards involved, the necessary precautions to be taken, the use of protective equipment and emergency equipment, the enclosed-space entry procedures, rescue procedures, and safe work practices, including instructions as to the hazards they may encounter.

(d) Attendants. While work is being performed in the enclosed space, an attendant with first-aid training shall be immediately available outside the enclosed space to provide assistance if a hazard exists because of traffic patterns in the area of the opening used for entry. The attendant is not precluded from performing other duties outside the enclosed space if these duties do not distract the attendant from monitoring employees within the space or ensuring that it is safe for employees to enter and exit the space.

NOTE: Section 2943(b)(4) requires an attendant while work is being performed in a manhole or vault containing energized electrical equipment.

(e) Rescue Equipment. Employers shall provide equipment to ensure the prompt and safe rescue of employees from the enclosed space.

(f) Evaluating Potential Hazards. Before any entrance cover to an enclosed space is removed, the employer shall determine whether it is safe to do so by checking for the presence of any atmospheric pressure or temperature differences and by evaluating whether there might be a hazardous atmosphere in the space. Any conditions making it unsafe to remove the cover shall be eliminated before the cover is removed.

NOTE to subsection (f): The determination called for in this subsection may consist of a check of the conditions that might foreseeably be in the enclosed space. For example, the cover could be checked to see if it is hot and, if it is fastened in place, could be loosened gradually to release any residual pressure. An evaluation also needs to be made of whether conditions at the site could cause a hazardous atmosphere, such as an oxygen-deficient or flammable atmosphere, to develop within the space.

(g) Removing Covers. When covers are removed from enclosed spaces, the opening shall be promptly guarded by a railing, temporary cover, or other barrier designed to prevent an accidental fall through the opening and to protect employees working in the space from objects entering the space.

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(h) Hazardous Atmosphere. Employees shall not enter any enclosed space while it contains a hazardous atmosphere, unless the entry conforms to Article 37 of the Construction Safety Orders for construction or Section 5157 of the General Industry Safety Orders.

NOTE to subsection (h): See Section 2943(b) for additional requirements on attendants for work in manholes and vaults.

(i) Calibration of Test Instruments. Test instruments used to monitor atmospheres in enclosed spaces shall be kept in calibration and shall have a minimum accuracy of + or - 10 percent.

(j) Testing. Before an employee enters an enclosed space, the air shall be tested with a direct reading meter or similar equipment capable of collection and immediate analysis of data samples without the need for an offsite evaluation. Testing is to determine whether dangerous air contamination, oxygen enrichment and/or an oxygen deficiency, and flammable gases and vapors exist in the enclosed space. The test for flammable gases or vapors shall be performed after oxygen testing to ensure the accuracy of the test for the flammability. The direct reading meter shall be approved for use in such explosive or flammable conditions as required by Section 2540.2. A written record of such testing results shall be made and kept at the work site for the duration of the work. Affected employees and/or their representative shall be afforded an opportunity to review and record the testing results.

(1) Where interconnected spaces are blinded off as a unit, each space shall be tested and the results recorded and the most hazardous condition so found shall govern procedures to be followed.

(2) If dangerous air contamination, oxygen enrichment and/or oxygen deficiency does not exist within the space, as demonstrated by tests, entry into and work within the space may proceed subject to the following provisions:

(A) Testing shall be conducted with sufficient frequency to ensure that the development of dangerous air contamination, oxygen enrichment and/or oxygen deficiency does not occur during the performance of any operation.

(B) If the development of dangerous air contamination, oxygen enrichment and/or an oxygen deficiency is imminent, the requirements prescribed by Article 37 of Construction Safety Orders or Section 5157 of the General Industry Safety Orders shall also apply.

(k) Ventilation and Monitoring. If dangerous air contamination, flammable gases or vapors are detected or if an oxygen deficiency is found, forced-air ventilation shall be used to maintain

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oxygen at a safe level, to prevent dangerous air contamination, and accumulation of hazardous concentration of flammable gases and vapors. A continuous monitoring program is required to ensure that no increase in air contaminants, flammable gas or vapor concentration above safe levels occurs within in the enclosed space.

(*l*) Specific Ventilation Requirements. If continuous forced-air ventilation is used, it shall begin before entry is made and shall be maintained long enough for the employer to be able to demonstrate that a safe atmosphere exists before employees are allowed to enter the work area. The forced-air ventilation shall be so directed as to ventilate the immediate area where employees are present within the enclosed space and shall continue until all employees leave the enclosed space.

(m) Air Supply. The air supply for the continuous forced-air ventilation shall be from a clean source and shall not increase the hazards in the enclosed space.

(n) No source of ignition shall be introduced until the implementation of appropriate provisions of this section have ensured that dangerous air contamination due to oxygen enrichment, flammable and/or explosive substances does not exist.

(o) Open Flames.

(1) If open flames are used in enclosed spaces, a test for flammable gases and vapors shall be made immediately before the open flame device is used and at least once per hour while the device is used in the space. Testing shall be conducted more frequently if conditions present in the enclosed space indicate that once per hour is insufficient to detect hazardous accumulations of flammable gases or vapors.

(2) Whenever oxygen-consuming equipment such as salamanders, plumbers' torches or furnaces, and the like, are to be used, measures shall be taken to ensure adequate combustion air and exhaust gas venting.

(p) To the extent feasible, provision shall be made to permit ready entry and exit.

(q) Where it is not feasible to provide for ready exit from spaces equipped with automatic fire suppression systems employing harmful design concentrations of toxic or oxygen-displacing gases, or total foam flooding, such systems shall be deactivated. Where it is not practical or safe to deactivate such systems, the provisions of Section 5144 related to the use of respiratory protective equipment shall apply during entry into and work within such spaces and entry of the space shall be in accordance with Article 37 of the Construction Safety Orders or Section 5157 of the General Industry Safety Orders.

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NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 36. Work Procedures and Operating Procedures

Amend Section 2944 to read:

§2944. Work on or in Proximity to Conductors and Equipment Located in High-Voltage Stations, or Switchyards.

(a) This section applies to only that work performed on or in proximity to exposed high-voltage conductors and equipment which is not covered by Sections 2941, 2942 and 2943 of these orders, such as stations, switchyards and other similar installations.

~~(b) Identification. All switchboards shall be provided with readily legible circuit identification. Identification shall be provided for each circuit breaker, each set of disconnecting switches, and each set of grounding switches.~~
[Existing subsection (b) is relocated to new subsection (d)]

(b) Substation Fences. Conductive fences around substations shall be grounded. When a substation fence is expanded or a section is removed, fence sections shall be isolated, grounded, or bonded as necessary to protect employees from hazardous differences in electric potential. When a substation fence is extended or moved, provisions shall be made to comply with Article 17, Section 2812.1 of these orders.
[New subsection (b), with revisions, is relocated from existing subsection (k)]

~~(c) Work Near Energized Equipment and Facilities.~~

~~(1) No person other than a qualified electrical worker shall perform work or take any conducting object within the area where there is a hazard of contact with energized conductors unless directly under the observation of a qualified person.~~

~~(2) When working around energized equipment, precautions shall be taken to prevent any material or tools from accidentally contacting energized conductors or equipment.~~

~~(3) Temporary Barriers. Suitable temporary barriers in or adjacent to the work area shall be used to prevent accidental contact by workers with energized high voltage parts.~~

~~(4) Tape Barricades. Suitable barricade tape shall be used to mark off and bar approach to dangerous areas. An employee shall not be permitted to cross over or under the tape while it is barricading an area, except in an emergency or when work in progress requires the~~

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~~employee to enter the dangerous area. While in the area, the employee shall be continuously watched by a qualified person for the purpose of preventing an accident.~~
[Existing subsection (c) is relocated to new subsection (g)]

(c) Substation Entry.

(1) Report upon entering. Upon entering an attended substation, each employee, other than employees regularly working in the station, shall report his or her presence to the employee in charge of substation activities to receive information on special system conditions affecting employee safety.

(2) The job briefing required by Section 2940 of these Orders and Section 3203 of the GISO shall cover information on special system conditions affecting employee safety, including the location of energized equipment in or adjacent to the work area and the limits of any deenergized work area.

(d) Identification. All switchboards shall be provided with readily legible circuit identification. Identification shall be provided for each circuit breaker, each set of disconnecting switches, and each set of grounding switches.
[New subsection (d) is relocated from existing subsection (b)]

~~(d) Mechanized Equipment.~~

~~(1) Use of vehicles, gin poles, cranes and other equipment in restricted or hazardous areas shall at all times be controlled by designated employees.~~

~~(2) Mobile cranes or derricks shall not be permitted closer to exposed energized conductors or equipment than the distances set forth in Section 2940.2(b), Table 2940.2 unless the hoisting equipment is insulated for the voltage involved.~~
[Existing subsection (d) is relocated to new subsection (h)]

~~(e)(1) Working on Conductors or Equipment Energized at 7, 500 Volts or Less. When working on conductors or equipment energized at 7, 500 volts or less, all engerized conductors or equipment and all grounded conductors or equipment, including guy wires, within reach of any part of the body, shall be isolated, barricaded, or covered with suitable protective equipment. EXCEPTION: That part of the conductor or equipment on which work is to be performed need not be covered.~~

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~~(2) Employees shall not be permitted to touch or work on any exposed energized conductor or equipment except when wearing suitable rubber gloves with protectors, or when using other suitable devices.~~

[Existing subsection (e) is relocated to new subsection (i)]

(e) Draw-Out-Type Circuit Breakers. The employer shall ensure that, when employees remove or insert draw-out type circuit breakers, the breaker is in the open position. The employer shall also render the control circuit inoperable if the design of the equipment permits.

(f) Guarding of Energized Parts.

(1) Enclosure and guarding shall be in accordance with Section 2340.17 of the Low-Voltage Electrical Safety Orders or Article 17 or Article 35 of the High-Voltage Electrical Safety Orders.

(g) Work Near Energized Equipment and Facilities.

(1) No person other than a qualified electrical worker shall perform work or take any conducting object within the area where there is a hazard of contact with energized conductors unless directly under the observation of a qualified person.

(2) When working around energized equipment, precautions shall be taken to prevent any material or tools from accidentally contacting energized conductors or equipment.

(3) Temporary Barriers. Suitable temporary barriers in or adjacent to the work area shall be used to prevent accidental contact by workers with energized high voltage parts.

(4) Tape Barricades. Suitable barricade tape shall be used to mark off and bar approach to dangerous areas. An employee shall not be permitted to cross over or under the tape while it is barricading an area, except in an emergency or when work in progress requires the employee to enter the dangerous area. While in the area, the employee shall be continuously watched by a qualified person for the purpose of preventing an accident.

[New subsection (g) is relocated from existing subsection (c)]

(h) Mechanized Equipment.

(1) Use of vehicles, gin poles, cranes and other equipment in restricted or hazardous areas shall at all times be controlled by designated employees.

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(2) Mobile cranes or derricks shall not be permitted closer to exposed energized conductors or equipment than the distances set forth in Section 2940.2 unless the hoisting equipment is insulated for the voltage involved.

[New subsection (h), with revisions, is relocated from existing subsection (d)]

(i)(1) Working on Conductors or Equipment Energized at 7,500 Volts or Less. When working on conductors or equipment energized at 7,500 volts or less, all energized conductors or equipment and all grounded conductors or equipment, including guy wires, within reach of any part of the body, shall be isolated, barricaded, or covered with suitable protective equipment. EXCEPTION: That part of the conductor or equipment on which work is to be performed need not be covered.

(2) Employees shall not be permitted to touch or work on any exposed energized conductor or equipment except when wearing suitable rubber gloves with protectors, or when using other suitable devices.

[New subsection (i) is relocated from existing subsection (e)]

~~(f)~~(j) Working on Conductors or Equipment Energized in Excess of 7,500 Volts. All work on conductors or equipment energized in excess of 7,500 volts shall be done by means of suitable devices. Rubber gloves shall not be considered to be suitable devices.

[New subsection (j) is relocated from existing subsection (f)]

~~(g)~~(k) Working on De-energized Conductors or Equipment. When working on de-energized conductors or equipment, all exposed energized conductors or equipment regardless of voltage within reach of any part of the body, shall be covered with suitable protective equipment.

[New subsection (k) is relocated from existing subsection (g)]

~~(h)~~(*l*) Grounding De-energized Conductors or Equipment.

(1) Any exposed ungrounded part of conductors or equipment not worked upon in accordance with the provisions of subsections (i) ~~(e)~~ or (j) ~~(f)~~ above, shall not be worked upon until ~~the following~~ provisions in Sections 2940.14 and 2940.15 have been complied with~~:~~.

~~(A) Conductors or equipment to be grounded are clearly identified and isolated from all sources of voltage.~~

~~(B) Notification has been obtained from the designated employee that all switches or other points of isolation through which electric energy may be supplied to the conductors or equipment to be worked on have been opened and are plainly tagged~~

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~~indicating that employees are at work, and where the design permits, they have been rendered inoperable.~~

~~(C) Visual inspection and tests are made to insure that equipment or conductors have been de-energized.~~

~~(D) Guards or barriers are installed as necessary to prevent contact with exposed energized conductors or equipment.~~

~~(E) Grounds are applied, except where their installation or use increases the working hazard. Grounds shall be permitted to be removed for test purposes.~~

~~(F) Suitable grounding devices shall be used. They shall be first connected to a ground before being brought into contact with any de-energized conductor or equipment to be grounded. The other end shall be attached and removed by means of insulated tools or other suitable devices. When removed, they shall be removed from all conductors or equipment before being disconnected from ground~~

~~(G) When required, there shall be a minimum of one ground on the conductors or equipment being worked on:~~

~~1. between the place where the work is being done and each possible source of supply,~~

~~2. at the work location, or~~

~~3. as close as practicable to the source of supply.~~

~~(H) One of the grounding devices shall be visible to at least one member of the crew unless one of the grounding devices is accessible only to authorized persons.~~

~~(I) Grounding devices shall be capable of conducting the anticipated fault current and shall have a minimum conductance of No. 2 AWG copper.~~

~~(J) When more than one independent crew requires the same conductors or equipment to be de-energized, a tag for each such independent crew shall be placed on the conductors or equipment. Where clearances for such independent crews are controlled by a designated authority having immediate jurisdiction over the conductors or equipment involved, only one tag need be installed.~~

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~~(2) Upon completion of work the employee in charge of each independent crew shall determine that all employees in the crew are clear and shall report to the designated authority that all tags protecting the crew may be removed.~~

[New subsection (l), with revisions, is relocated from existing subsection (h)]

~~(3) Prior to the energizing of the conductors or equipment, the employer shall ascertain that all employees are clear and all grounds are removed~~.

~~(i)~~(m) Access to Insulators. The employer shall furnish suitable aerial lift equipment, portable platforms, or other devices to permit employees to work on insulators or bushings attached to poles, towers, structures, or equipment when such insulators or bushings are not otherwise safely accessible.

[New subsection (m) is relocated from existing subsection (i)]

~~(j)~~(n) Prior to climbing poles or other elevated structures supporting overhead electrical lines or equipment, an inspection shall be made to ensure that such poles or structure 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.

[New subsection (n) is relocated from existing subsection (j)]

~~(k) Substation Fences. When a substation fence is extended or moved provisions shall be made to comply with Article 17, Section 2812(e) of these orders.~~

[Existing subsection (k) is relocated to new subsection (b), with revisions]

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 36. Work Procedures and Operating Procedures

Add new Section 2944.1 to read:

§2944.1. Power Generation.

(a) This section provides additional requirements and related work practices for power generation plants.

(1) Interlocks and other safety devices.

(A) Interlocks and other safety devices shall be maintained in a safe, operable condition.

(B) No interlock or other safety device shall be modified to defeat its function, except for test, repair, or adjustment of the device.

(2) Changing brushes. Before exciter or generator brushes are changed while the generator is in service, the exciter or generator field shall be checked to determine whether a ground condition exists. The brushes shall not be changed while the generator is energized if a ground condition exists.

(3) Access and working space. The employer shall provide and maintain sufficient access and working space about electric equipment to permit ready and safe operation and maintenance of such equipment by employees.

(4) Rooms and other spaces containing electric supply equipment shall be guarded in accordance with the requirements of Article 17 of these Orders.

(5) All live energized parts operating at more than 50 volts and less than or equal to 600 volts (nominal) shall be guarded in accordance Section 2340.17 of the LVESO and all live energized parts operating above 600 volts (nominal) shall be guarded by the requirements of Article 35 of these Orders.

(b) Water or Steam Spaces. The following requirements apply to work in water and steam spaces associated with boilers:

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(1) A designated employee shall inspect conditions before work is permitted and after its completion. Eye protection, or full face protection if necessary, shall be worn at all times when condenser, heater, or boiler tubes are being cleaned.

(2) Where it is necessary for employees to work near tube ends during cleaning, shielding shall be installed at the tube ends.

(c) Chemical Cleaning of Boilers and Pressure Vessels. The following requirements apply to chemical cleaning of boilers and pressure vessels:

(1) Areas where chemical cleaning is in progress shall be cordoned off to restrict access during cleaning. If flammable liquids, gases, or vapors or combustible materials will be used or might be produced during the cleaning process, the following requirements also apply:

(A) The area shall be posted with signs restricting entry and warning of the hazards of fire and explosion; and

(B) Smoking, welding, and other possible ignition sources are prohibited in these restricted areas.

(2) The number of personnel in the restricted area shall be limited to those necessary to accomplish the task safely.

(d) Boilers.

(1) Before internal furnace or ash hopper repair work is started overhead areas shall be inspected for possible falling objects. If the hazard of falling objects exists, overhead protection such as planking or nets shall be provided.

(2) When opening an operating boiler door, employees shall stand clear of the opening of the door to avoid the heat blast and gases which may escape from the boiler.

(e) Chlorine Systems.

(1) Chlorine system enclosures shall be posted with signs restricting entry and warning of the hazard to health and the hazards of fire and explosion.

(2) Only qualified employees may enter the restricted area. Additionally, the number of personnel shall be limited to those necessary to accomplish the task safely.

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(3) Emergency repair kits shall be available near the shelter or enclosure to allow for the prompt repair of leaks in chlorine lines, equipment, or containers.

(4) Before repair procedures are started, chlorine tanks, pipes, and equipment shall be purged with dry air and isolated from other sources of chlorine.

(5) The employer shall ensure that chlorine is not mixed with materials that would react with the chlorine in a dangerously exothermic or other hazardous manner.

(f) Turbine Generators.

(1) Smoking and other ignition sources are prohibited near hydrogen or hydrogen sealing systems, and signs warning of the danger of explosion and fire shall be posted.

(2) Excessive hydrogen makeup or abnormal loss of pressure shall be considered as an emergency and shall be corrected immediately.

(3) A sufficient quantity of inert gas shall be available to purge the hydrogen from the largest generator.

(g) Coal and Ash Handling.

(1) Only designated persons shall operate railroad equipment.

(2) Before a locomotive or locomotive crane is moved, a warning shall be given to employees in the area.

(3) Employees engaged in switching or dumping cars shall not use their feet to line up drawheads.

(4) Drawheads and knuckles shall not be shifted while locomotives or cars are in motion.

(5) When a railroad car is stopped for unloading, the car shall be secured from displacement that could endanger employees.

(6) An emergency means of stopping dump operations shall be provided at railcar dumps.

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(7) The employer shall ensure that employees who work in coal- or ash handling conveyor areas are trained and knowledgeable in conveyor operation and in the requirements of subsections (g)(8) through (g)(12) of this section.

(8) Employees shall not ride a coal or ash-handling conveyor belt at any time. Employees shall not cross over the conveyor belt, except at walkways, unless the conveyor's energy source has been deenergized and has been locked out or tagged in accordance with Section 2940.13.

(9) A conveyor that could cause injury when started shall not be started until personnel in the area are alerted by a signal or by a designated person that the conveyor is about to start.

(10) If a conveyor that could cause injury when started is automatically controlled or is controlled from a remote location, an audible device shall be provided that sounds an alarm that will be recognized by each employee as a warning that the conveyor will start and that can be clearly heard at all points along the conveyor where personnel may be present. The warning device shall be actuated by the device starting the conveyor and shall continue for a period of time before the conveyor starts that is long enough to allow employees to move clear of the conveyor system. A visual warning may be used in place of the audible device if the employer can demonstrate that it will provide an equally effective warning in the particular circumstances involved. However if the employer can demonstrate that the system's function would be seriously hindered by the required time delay, warning signs may be provided in place of the audible warning device. If the system was installed before January 31, 1995, warning signs may be provided in place of the audible warning device until such time as the conveyor or its control system is rebuilt or rewired. These warning signs shall be clear, concise, and legible and shall indicate that conveyors and allied equipment may be started at any time, that danger exists, and that personnel shall keep clear. These warning signs shall be provided along the conveyor at areas not guarded by position or location.

(11) Remotely and automatically controlled conveyors, and conveyors that have operating stations which are not manned or which are beyond voice and visual contact from drive areas, loading areas, transfer points, and other locations on the conveyor path not guarded by location, position, or guards shall be furnished with emergency stop buttons, pull cords, limit switches, or similar emergency stop devices. However, if the employer can demonstrate that the design, function, and operation of the conveyor do not expose an employee to hazards, an emergency stop device is not required.

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(A) Emergency stop devices shall be easily identifiable in the immediate vicinity of such locations.

(B) An emergency stop device shall act directly on the control of the conveyor involved and shall not depend on the stopping of any other equipment.

(C) Emergency stop devices shall be installed so that they cannot be overridden from other locations.

(12) Where coal-handling operations may produce a combustible atmosphere from fuel sources or from flammable gases or dust, sources of ignition shall be eliminated or safely controlled to prevent ignition of the combustible atmosphere.

NOTE to subsection (g)(12): Locations that are hazardous because of the presence of combustible dust are classified as Class II hazardous locations. See Section 5174.

(13) An employee shall not work on or beneath overhanging coal in coal bunkers, coal silos, or coal storage areas, unless the employee is protected from all hazards posed by shifting coal.

(14) An employee entering a bunker or silo to dislodge the contents shall wear a body harness with lifeline attached. The lifeline shall be secured to a fixed support outside the bunker and shall be attended at all times by an employee located outside the bunker or facility.

(h) Hydroplants and Equipment. Employees working on or close to water gates, valves, intakes, forebays, flumes, or other locations where increased or decreased water flow or levels may pose a significant hazard shall be warned and shall vacate such dangerous areas before water flow changes are made.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Add new Appendix A to Article 36 to follow Section 2945 to read:

Appendix A

WORKING ON EXPOSED ENERGIZED PARTS

I. Introduction

Electric utilities design electric power generation, transmission, and distribution installations to meet National Electrical Safety Code (NESC), ANSI C2, requirements. Electric utilities also design transmission and distribution lines to limit line outages as required by system reliability criteria[1] and to withstand the maximum overvoltages impressed on the system. Conditions such as switching surges, faults, and lightning can cause overvoltages. Electric utilities generally select insulator design and lengths and the clearances to structural parts so as to prevent outages from contaminated line insulation and during storms. Line insulator lengths and structural clearances have, over the years, come closer to the minimum approach distances used by workers. As minimum approach distances and structural clearances converge, it is increasingly important that system designers and system operating and maintenance personnel understand the concepts underlying minimum approach distances.

The information in this appendix will assist employers in complying with the minimum approach-distance requirements contained in Section 2940.2. Employers shall use the technical criteria and methodology presented in this appendix in establishing minimum approach distances in accordance with Section 2940.2(c) and Table 2940.2-1 and Table 2940.2-6 . This appendix provides essential background information and technical criteria for the calculation of the required minimum approach distances for live-line work on electric power generation, transmission, and distribution installations.

Unless an employer is using the maximum transient overvoltages specified in Table 2940.2-5 for voltages over 72.5 kilovolts, the employer shall use persons knowledgeable in the techniques discussed in this appendix, and competent in the field of electric transmission and distribution system design, to determine the maximum transient overvoltage.

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II. General

A. *Definitions.* The following definitions from Section 2700 relate to work on or near electric power generation, transmission, and distribution lines and equipment and the electrical hazards they present.

Exposed. Not isolated or guarded.

Guarded. Covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach to a point of danger or contact by persons or objects.

NOTE to the definition of "guarded": Wires that are insulated, but not otherwise protected, are not guarded.

Insulated. Separated from other conducting surfaces by a dielectric (including air space) offering a high resistance to the passage of current.

NOTE to the definition of "insulated": When any object is said to be insulated, it is understood to be insulated for the conditions to which it normally is subjected. Otherwise, it is, for the purpose of this section, uninsulated.

Isolated (as applied to location). Not readily accessible to persons unless special means for access are used.

Statistical Sparkover Voltage. A transient overvoltage level that produces a 97.72-percent probability of sparkover (that is, two standard deviations above the voltage at which there is a 50-percent probability of sparkover).

Statistical Withstand Voltage. A transient overvoltage level that produces a 0.14-percent probability of sparkover (that is, three standard deviations below the voltage at which there is a 50-percent probability of sparkover).

B. *Installations energized at 50 to 300 volts.* The hazards posed by installations energized at 50 to 300 volts are the same as those found in many other workplaces. That is not to say that there is no hazard, but the complexity of electrical protection required does not compare to that required for high voltage systems. The employee shall avoid contact with the exposed parts, and the protective equipment used (such as rubber insulating gloves) shall provide insulation for the voltages involved.

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C. *Exposed energized parts over-600 volts AC.* Section 2940.2 (a) requires the employer to establish minimum approach distances no less than the distances computed by Table 2940.2-1 for ac systems so that employees can work safely without risk of sparkover.[2]

Unless the employee is using electrical protective equipment, air is the insulating medium between the employee and energized parts. The distance between the employee and an energized part shall be sufficient for the air to withstand the maximum transient overvoltage that can reach the worksite under the working conditions and practices the employee is using. This distance is the minimum air insulation distance, and it is equal to the electrical component of the minimum approach distance.

Normal system design may provide or include a means (such as lightning arrestors) to control maximum anticipated transient overvoltages, or the employer may use temporary devices (portable protective gaps) or measures (such as preventing automatic circuit breaker reclosing) to achieve the same result. Subsection (a)(1) of Section 2940.2 requires the employer to determine the maximum anticipated per-unit transient overvoltage, phase-to-ground, through an engineering analysis or assume a maximum anticipated per-unit transient overvoltage, phase-to-ground, in accordance with Table 2940.2-5, which specifies the following maximums for ac systems:

72.6 to 420.0 kilovolts-3.5 per unit
420.1 to 550.0 kilovolts-3.0 per unit
550.1 to 800.0 kilovolts-2.5 per unit

See Section IV.A.2, later in this appendix, for additional discussion of maximum transient overvoltages.

D. *Types of exposures.* Employees working on or near energized electric power generation, transmission, and distribution systems face two kinds of exposures: Phase to-ground and phase-to-phase. The exposure is phase-to-ground: (1) With respect to an energized part, when the employee is at ground potential or (2) with respect to ground, when an employee is at the potential of the energized part during live-line barehand work, which requires a permanent variance. The exposure is phase-to phase, with respect to an energized part, when an employee is at the potential of another energized part (at a different potential) during live-line bareh and work.

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III. Determination of Minimum Approach Distances for AC Voltages Greater Than 300 Volts

A. Voltages of 301 to 5,000 volts. Test data generally forms the basis of minimum air insulation distances. The lowest voltage for which sufficient test data exists is 5,000 volts, and these data indicate that the minimum air insulation distance at that voltage is 20 millimeters (1 inch). Because the minimum air insulation distance increases with increasing voltage, and, conversely, decreases with decreasing voltage, an assumed minimum air insulation distance of 20 millimeters will protect against sparkover at voltages of 301 to 5,000 volts. Thus, 20 millimeters is the electrical component of the minimum approach distance for these voltages.

B. Voltages of 5.1 to 72.5 kilovolts. For voltages from 5.1 to 72.5 kilovolts, the Department of Labor, Occupational Safety and Health Administration bases the methodology for calculating the electrical component of the minimum approach distance on Institute of Electrical and Electronic Engineers (IEEE) Standard 4-1995, Standard Techniques for High-Voltage Testing. Table 1 lists the critical sparkover distances from that standard as listed in IEEE Std 516-2009, IEEE Guide for Maintenance Methods on Energized Power Lines.

TABLE 1-SPARKOVER DISTANCE FOR ROD-TO-ROD GAP

60 Hz Rod-to-Rod sparkover (kV peak)	Gap spacing from IEEE Std 4-1995 (cm)
25	2
36	3
46	4
53	5
60	6
70	8
79	10
86	12
95	14
104	16

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112	18
120	20
143	25
167	30
192	35
218	40
243	45
270	50
322	60

Source: IEEE Std 516-2009.
To use this table to determine the electrical component of the minimum approach distance, the employer shall determine the peak phase-to-ground transient overvoltage and select a gap from the table that corresponds to that voltage as a withstand voltage rather than a critical sparkover voltage. To calculate the electrical component of the minimum approach distance for voltages between 5 and 72.5 kilovolts, use the following procedure:

1. Divide the phase-to-phase voltage by the square root of 3 to convert it to a phase-to-ground voltage.
2. Multiply the phase-to-ground voltage by the square root of 2 to convert the rms value of the voltage to the peak phase-to-ground voltage.
3. Multiply the peak phase-to-ground voltage by the maximum per-unit transient overvoltage, which, for this voltage range, is 3.0, as discussed later in this appendix. This is the maximum phase-to-ground transient overvoltage, which corresponds to the withstand voltage for the relevant exposure.[3]
4. Divide the maximum phase-to-ground transient overvoltage by 0.85 to determine the corresponding critical sparkover voltage. (The critical sparkover voltage is 3 standard deviations (or 15 percent) greater than the withstand voltage.)
5. Determine the electrical component of the minimum approach distance from Table 1 through interpolation.

Table 2 illustrates how to derive the electrical component of the minimum approach distance for voltages from 5.1 to 72.5 kilovolts, before the application of any altitude correction factor, as explained later.

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TABLE 2-CALCULATING THE ELECTRICAL COMPONENT OF MAD
751 V TO 72.5 kV

Step	Maximum system phase-to-phase voltage (kV)			
	15	36	46	72.5
1. Divide by √3	8.7	20.8	26.6	41.9
2. Multiply by √2	12.2	29.4	37.6	59.2
3. Multiply by 3.0.	36.7	88.2	112.7	177.6
4. Divide by 0.85.	43.2	103.7	132.6	208.9
5. Interpolate from Table 1.	3+(7.2/10)*1	14+(8.7/9)*2	20+(12.6/23)*5	35+(16.9/26)*5
Electrical component of MAD (cm)	3.72	15.93	22.74	38.25

C. Voltages of 72.6 to 800 kilovolts. For voltages of 72.6 kilovolts to 800 kilovolts, this section bases the electrical component of minimum approach distances, before the application of any altitude correction factor, on the following formula:
Equation 1-For Voltages of 72.6 kV to 800 kV

$D = 0.3048(C + a)\, V_{L\text{-}G} T$

Where:
D = Electrical component of the minimum approach distance in air in meters;
C = a correction factor associated with the variation of gap sparkover with voltage;
a = A factor relating to the saturation of air at system voltages of 345 kilovolts or higher; [4]
$V_{L\text{-}G}$ = Maximum system line-to-ground rms voltage in kilovolts-it should be the "actual" maximum, or the normal highest voltage for the range (for example, 10 percent above the nominal voltage); and
T = Maximum transient overvoltage factor in per unit.

In Equation 1, C is 0.01: (1) For phase-to-ground exposures that the employer can demonstrate consist only of air across the approach distance (gap) and (2) for phase-to phase exposures if the employer can demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap. Otherwise, C is 0.011.

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In Equation 1, the term *a* varies depending on whether the employee's exposure is phase-to-ground or phase-to-phase and on whether objects are in the gap. The employer shall use the equations in Table 3 to calculate *a*. Sparkover test data with insulation spanning the gap form the basis for the equations for phase-to-ground exposures, and sparkover test data with only air in the gap form the basis for the equations for phase-to phase exposures. The phase-to-ground equations result in slightly higher values of a, and, consequently, produce larger minimum approach distances, than the phase-to-phase equations for the same value of V_{Peak}.

TABLE 3-EQUATIONS FOR CALCULATING THE SURGE FACTOR, *a*

Phase-to-ground exposures			
$V_{Peak} = T_{L-G}V_{L-G}\sqrt{2}$ A	635 kV or less 0	635.1 to 915 kV (V_{Peak}-635)/140,000	915.1 to 1,050 kV (V_{Peak}-645)/135,000
$V_{Peak} = T_{L-G}V_{L-G}\sqrt{2}$	More than 1,050 kV		
A	(VPeak-675)/125,000		
Phase-to-phase exposures [1]			
$V_{Peak} = (1.35T_{L-G} + 0.45)V_{L-G}\sqrt{2}$ a	630 kV or less 0	630.1 to 848 kV (V_{Peak}-630)/155,000	848.1 to 1,131 kV (V_{Peak}-633.6)/152,207
$V_{Peak} = (1.35T_{L-G} + 0.45)V_{L-G}\sqrt{2}$ a	1,131.1 to 1,485 kV (V_{Peak}-628)/153,846	More than 1,485 kV (V_{Peak}-350.5)/203,666	

[1] Use the equations for phase-to-ground exposures (with V_{Peak} for phase-to-phase exposures) unless the employer can demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap.

In Equation 1, T is the maximum transient overvoltage factor in per unit. As noted earlier, Section 2940.2 (a)(1)(A) requires the employer to determine the maximum anticipated per-unit transient overvoltage, phase-to-ground, through an engineering analysis or assume a maximum anticipated per-unit transient overvoltage, phase-to-ground, in accordance with Table 2940.2-5. For phase-to-ground exposures, the employer uses this value, called TL-G, as T in Equation 1. IEEE Std 516-2009 provides the following formula to calculate the phase-to-phase maximum transient overvoltage, TL-L, from TL-G:

$$T_{L-L} = 1.35T_{L-G} + 0.45$$

For phase-to-phase exposures, the employer uses this value as T in Equation 1.

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D. *Provisions for inadvertent movement.* The minimum approach distance shall include an "adder" to compensate for the inadvertent movement of the worker relative to an energized part or the movement of the part relative to the worker. This "adder" shall account for this possible inadvertent movement and provide the worker with a comfortable and safe zone in which to work. Employers shall add the distance for inadvertent movement (called the "ergonomic component of the minimum approach distance") to the electrical component to determine the total safe minimum approach distances used in live-line work.

The US Department of Labor, Occupational Safety and Health Administration based the ergonomic component of the minimum approach distance on response time-distance analysis. This technique uses an estimate of the total response time to a hazardous incident and converts that time to the distance traveled. For example, the driver of a car takes a given amount of time to respond to a "stimulus" and stop the vehicle. The elapsed time involved results in the car's traveling some distance before coming to a complete stop. This distance depends on the speed of the car at the time the stimulus appears and the reaction time of the driver.

In the case of live-line work, the employee shall first perceive that he or she is approaching the danger zone. Then, the worker responds to the danger and shall decelerate and stop all motion toward the energized part. During the time it takes to stop, the employee will travel some distance. This is the distance the employer shall add to the electrical component of the minimum approach distance to obtain the total safe minimum approach distance.

At voltages from 751 volts to 72.5 kilovolts,[5] the electrical component of the minimum approach distance is smaller than the ergonomic component. At 72.5 kilovolts, the electrical component is only a little more than 0.3 meters (1 foot). An ergonomic component of the minimum approach distance shall provide for all the worker's unanticipated movements. At these voltages, workers generally use rubber insulating gloves; however, these gloves protect only a worker's hands and arms. Therefore, the energized object shall be at a safe approach distance to protect the worker's face. In this case, 0.61 meters (2 feet) is a sufficient and practical ergonomic component of the minimum approach distance.

For voltages between 72.6 and 800 kilovolts, employees shall use different work practices during energized line work. Generally, employees use live-line tools (hot sticks) to perform work on energized equipment. These tools, by design, keep the energized part at a constant distance from the employee and, thus, maintain the appropriate minimum approach distance automatically.

The location of the worker and the type of work methods the worker is using also influence the length of the ergonomic component of the minimum approach distance. In this higher voltage range, the employees use work methods that more tightly control their movements than when the

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workers perform work using rubber insulating gloves. The worker, therefore, is farther from the energized line or equipment and shall be more precise in his or her movements just to perform the work. For these reasons, this section adopts an ergonomic component of the minimum approach distance of 0.31 m (1 foot) for voltages between 72.6 and 800 kilovolts.

Table 4 summarizes the ergonomic component of the minimum approach distance for various voltage ranges.

TABLE 4-ERGONOMIC COMPONENT OF MINIMUM APPROACH DISTANCE

Voltage range (kV)	Distance	
	m	ft
0.301 to 0.750	0.31	1.0
0.751 to 72.5	0.61	2.0
72.6 to 800	0.31	1.0

NOTE: The employer shall add this distance to the electrical component of the minimum approach distance to obtain the full minimum approach distance.

The ergonomic component of the minimum approach distance accounts for errors in maintaining the minimum approach distance (which might occur, for example, if an employee misjudges the length of a conductive object he or she is holding), and for errors in judging the minimum approach distance. The ergonomic component also accounts for inadvertent movements by the employee, such as slipping. In contrast, the working position selected to properly maintain the minimum approach distance shall account for all of an employee's reasonably likely movements and still permit the employee to adhere to the applicable minimum approach distance. (See Figure 1.) Reasonably likely movements include an employee's adjustments to tools, equipment, and working positions and all movements needed to perform the work. For example, the employee should be able to perform all of the following actions without straying into the minimum approach distance:

- adjust his or her hardhat,
- maneuver a tool onto an energized part with a reasonable amount of overreaching or underreaching,
- reach for and handle tools, material, and equipment passed to him or her, and
- adjust tools, and replace components on them, when necessary during the work procedure.

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The training of qualified employees required under Section 2940(c), and the job planning and briefing required under Sections 3203(a) and 2940(e) shall address selection of a proper working position.

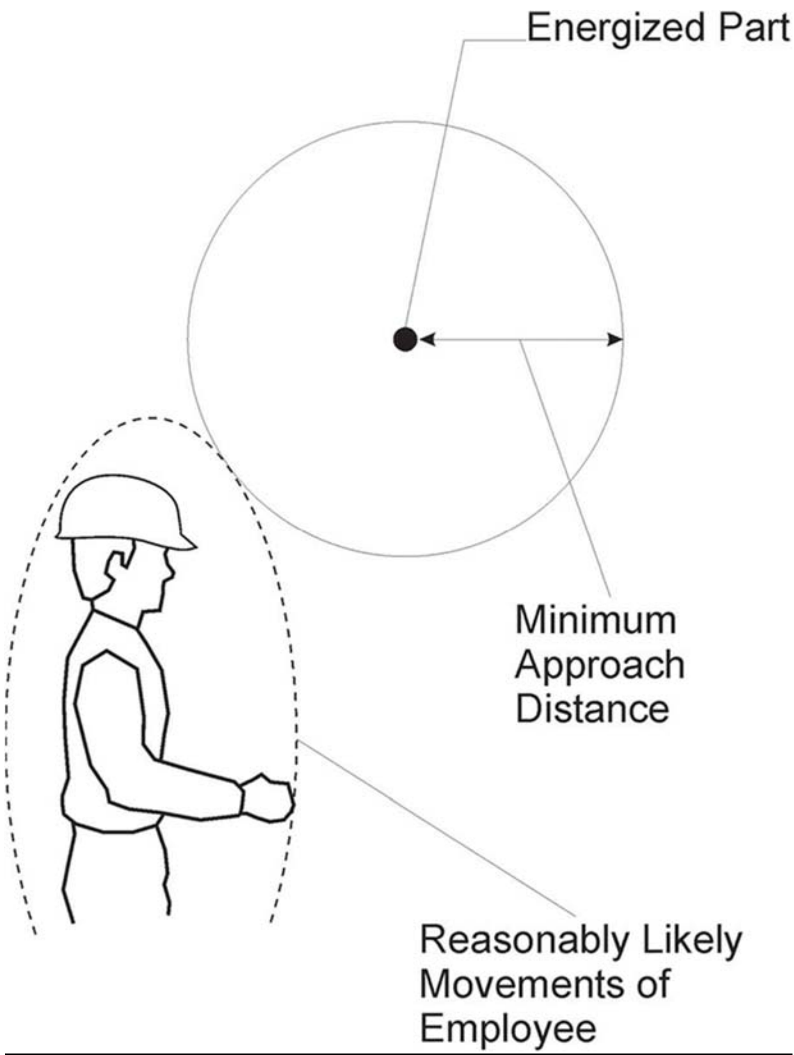

Figure 1 - Maintaining the Minimum Approach Distance

E. *Miscellaneous correction factors.* Changes in the air medium that forms the insulation influences the strength of an air gap. A brief discussion of each factor follows.

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1. *Dielectric strength of air.* The dielectric strength of air in a uniform electric field at standard atmospheric conditions is approximately 3 kilovolts per millimeter.[6]
The pressure, temperature, and humidity of the air, the shape, dimensions, and separation of the electrodes, and the characteristics of the applied voltage (wave shape) affect the disruptive gradient.

2. *Atmospheric effect.* The empirically determined electrical strength of a given gap is normally applicable at standard atmospheric conditions (20 °C, 101.3 kilopascals, 11 grams/cubic centimeter humidity). An increase in the density (humidity) of the air inhibits sparkover for a given air gap. The combination of temperature and air pressure that results in the lowest gap sparkover voltage is high temperature and low pressure. This combination of conditions is not likely to occur. Low air pressure, generally associated with high humidity, causes increased electrical strength. An average air pressure generally correlates with low humidity. Hot and dry working conditions normally result in reduced electrical strength. The equations for minimum approach distances in Table 2940.2-1 assume standard atmospheric conditions.

3. *Altitude.* The reduced air pressure at high altitudes causes a reduction in the electrical strength of an air gap. An employer shall increase the minimum approach distance by about 3 percent per 300 meters (1,000 feet) of increased altitude for altitudes above 900 meters (3,000 feet). Table 2940.2-7 specifies the altitude correction factor that the employer shall use in calculating minimum approach distances.

IV. Determining Minimum Approach Distances

A. *Factors Affecting Voltage Stress at the Worksite*

1. *System voltage (nominal).* The nominal system voltage range determines the voltage for purposes of calculating minimum approach distances. The employer selects the range in which the nominal system voltage falls, as given in the relevant table, and uses the highest value within that range in perunit calculations.

2. *Transient overvoltages.* Operation of switches or circuit breakers, a fault on a line or circuit or on an adjacent circuit, and similar activities may generate transient overvoltages on an electrical system. Each overvoltage has an associated transient voltage wave shape. The wave shape arriving at the site and its magnitude vary considerably.

In developing requirements for minimum approach distances, US Department of Labor, Occupational Safety and Health Administration considered the most common wave shapes and the magnitude of transient overvoltages found on electric power generation, transmission, and

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distribution systems. The equations in Table 2940.2-1 for minimum approach distances use per-unit maximum transient overvoltages, which are relative to the nominal maximum voltage of the system. For example, a maximum transient overvoltage value of 3.0 per unit indicates that the highest transient overvoltage is 3.0 times the nominal maximum system voltage.

3. *Typical magnitude of overvoltages.* Table 5 lists the magnitude of typical transient overvoltages.

TABLE 5-MAGNITUDE OF TYPICAL TRANSIENT OVERVOLTAGES

Cause	Magnitude (per unit)
Energized 200-mile line without closing resistors	3.5
Energized 200-mile line with one-step closing resistor	2.1
Energized 200-mile line with multistep resistor	2.5
Reclosing with trapped charge one-step	2.2
Opening surge with single restrike	3.0
Fault initiation unfaulted phase	2.1
Fault initiation adjacent circuit	2.5
Fault clearing	1.7 to 1.9

4. *Standard deviation-air-gap withstand.* For each air gap length under the same atmospheric conditions, there is a statistical variation in the breakdown voltage. The probability of breakdown against voltage has a normal (Gaussian) distribution. The standard deviation of this distribution varies with the wave shape, gap geometry, and atmospheric conditions. The withstand voltage of the air gap is three standard deviations (3s) below the critical sparkover voltage. (The critical sparkover voltage is the crest value of the impulse wave that, under specified conditions, causes sparkover 50 percent of the time. An impulse wave of three standard deviations below this value, that is, the withstand voltage, has a probability of sparkover of approximately 1 in 1,000.)

5. *Broken Insulators.* Tests show reductions in the insulation strength of insulator strings with broken skirts. Broken units may lose up to 70 percent of their withstand capacity. Because an employer cannot determine the insulating capability of a broken unit without testing it, the employer shall consider damaged units in an insulator to have no insulating value. Additionally, the presence of a live-line tool alongside an insulator string with broken units may further reduce

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the overall insulating strength. The number of good units that shall be present in a string for it to be "insulated" as defined by Section 2700 depends on the maximum overvoltage possible at the worksite.

B. *Minimum Approach Distances Based on Known, Maximum-Anticipated Per-Unit Transient Overvoltages*

1. *Determining the minimum approach distance for AC systems.* Under Section 2940.2(a)(1), the employer shall determine the maximum anticipated per-unit transient overvoltage, phase-to-ground, through an engineering analysis or shall assume a maximum anticipated per-unit transient overvoltage, phase-to-ground, in accordance with Table 2940.2-5. When the employer conducts an engineering analysis of the system and determines that the maximum transient overvoltage is lower than specified by Table 2940.2-5, the employer must ensure that any conditions assumed in the analysis, for example, that employees block reclosing on a circuit or install portable protective gaps, are present during energized work. To ensure that these conditions are present, the employer may need to institute new livework procedures reflecting the conditions and limitations set by the engineering analysis.

2. *Calculation of reduced approach distance values.* An employer may take the following steps to reduce minimum approach distances when the maximum transient overvoltage on the system (that is, the maximum transient overvoltage without additional steps to control overvoltages) produces unacceptably large minimum approach distances:

Step 1. Determine the maximum voltage (with respect to a given nominal voltage range) for the energized part.

Step 2. Determine the technique to use to control the maximum transient overvoltage. (See Sections IV.C and IV.D of this appendix.) Determine the maximum transient overvoltage that can exist at the worksite with that form of control in place and with a confidence level of 3s. This voltage is the withstand voltage for the purpose of calculating the appropriate minimum approach distance.

Step 3. Direct employees to implement procedures to ensure that the control technique is in effect during the course of the work.

Step 4. Using the new value of transient overvoltage in per unit, calculate the required minimum approach distance from Table 2940.2-1.

C. *Methods of Controlling Possible Transient Overvoltage Stress Found on a System*

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1. *Introduction.* There are several means of controlling overvoltages that occur on transmission systems. For example, the employer can modify the operation of circuit breakers or other switching devices to reduce switching transient overvoltages. Alternatively, the employer can hold the overvoltage to an acceptable level by installing surge arresters or portable protective gaps on the system. In addition, the employer can change the transmission system to minimize the effect of switching operations. Section 4.8 of IEEE Std 516-2009 describes various ways of controlling, and thereby reducing, maximum transient overvoltages.

2. *Operation of circuit breakers*.[7] The maximum transient overvoltage that can reach the worksite is often the result of switching on the line on which employees are working. Disabling automatic reclosing during energized line work, so that the line will not be reenergized after being opened for any reason, limits the maximum switching surge overvoltage to the larger of the opening surge or the greatest possible fault-generated surge, provided that the devices (for example, insertion resistors) are operable and will function to limit the transient overvoltage and that circuit breaker restrikes do not occur. The employer shall ensure the proper functioning of insertion resistors and other overvoltage-limiting devices when the employer's engineering analysis assumes their proper operation to limit the overvoltage level. If the employer cannot disable the reclosing feature (because of system operating conditions), other methods of controlling the switching surge level may be necessary.

Transient surges on an adjacent line, particularly for double circuit construction, may cause a significant overvoltage on the line on which employees are working. The employer's engineering analysis shall account for coupling to adjacent lines.

3. *Surge arresters.* The use of modern surge arresters allows a reduction in the basic impulse-insulation levels of much transmission system equipment. The primary function of early arresters was to protect the system insulation from the effects of lightning. Modern arresters not only dissipate lightning-caused transients, but may also control many other system transients caused by switching or faults.

The employer may use properly designed arresters to control transient overvoltages along a transmission line and thereby reduce the requisite length of the insulator string and possibly the maximum transient overvoltage on the line.[8]

4. *Switching Restrictions.* Another form of overvoltage control involves establishing switching restrictions, whereby the employer prohibits the operation of circuit breakers until certain system conditions are present. The employer restricts switching by using a tagging system, similar to that used for a permit, except that the common term used for this activity is a "hold-off" or "restriction." These terms indicate that the restriction does not prevent operation, but only modifies the operation during the livework activity.

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D. *Minimum Approach Distance Based on Control of Maximum Transient Overvoltage at the Worksite*

When the employer institutes control of maximum transient overvoltage at the worksite by installing portable protective gaps, the employer may calculate the minimum approach distance as follows:
Step 1. Select the appropriate withstand voltage for the protective gap based on system requirements and an acceptable probability of gap sparkover.[9]
Step 2. Determine a gap distance that provides a withstand voltage[10] greater than or equal to the one selected in the first step.[11]
Step 3. Use 110 percent of the gap's critical sparkover voltage to determine the phase-to-ground peak voltage at gap sparkover (VPPG Peak).
Step 4. Determine the maximum transient overvoltage, phase-to-ground, at the worksite from the following formula:

$$T = \frac{V_{PPG\,Peak}}{V_{L\text{-}G}\sqrt{2}}.$$

Step 5. Use this value of T[12] in the equation in Table 2940.2-1 to obtain the minimum approach distance. If the worksite is no more than 900 meters (3,000 feet) above sea level, the employer may use this value of T to determine the minimum approach distance from Table 14 through Table 21.

NOTE: All rounding shall be to the next higher value (that is, always round up).
Sample protective gap calculations.

Problem: Employees are to perform work on a 500-kilovolt transmission line at sea level that is subject to transient overvoltages of 2.4 p.u. The maximum operating voltage of the line is 550 kilovolts. Determine the length of the protective gap that will provide the minimum practical safe approach distance. Also, determine what that minimum approach distance is:

Step 1. Calculate the smallest practical maximum transient overvoltage (1.25 times the crest phase-to-ground voltage).[13]

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$$550kV \times \frac{\sqrt{2}}{\sqrt{3}} \times 1.25 = 561kV.$$

This value equals the withstand voltage of the protective gap.

Step 2. Using test data for a particular protective gap, select a gap that has a critical sparkover voltage greater than or equal to:

561kV ÷ 0.85 = 660kV

For example, if a protective gap with a 1.22-m (4.0-foot) spacing tested to a critical sparkover voltage of 665 kilovolts (crest), select this gap spacing.

Step 3. The phase-to-ground peak voltage at gap sparkover (VPPG Peak) is 110 percent of the value from the previous step:

665kV × 1.10 = 732kV

This value corresponds to the withstand voltage of the electrical component of the minimum approach distance.

Step 4. Use this voltage to determine the worksite value of T:

$$T = \frac{732}{564} = 1.7\,p.u.$$

Step 5. Use this value of T in the equation in Table ~~R-3~~ 2940.2-1 to obtain the minimum approach distance, or look up the minimum approach distance in Table 14 through Table 21: MAD = 2.29m (7.6 ft).

E. *Location of Protective Gaps*

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1. *Adjacent structures.* The employer may install the protective gap on a structure adjacent to the worksite, as this practice does not significantly reduce the protection afforded by the gap.

2. *Terminal stations.* Gaps installed at terminal stations of lines or circuits provide a level of protection; however, that level of protection shall not extend throughout the length of the line to the worksite. The use of substation terminal gaps raises the possibility that separate surges could enter the line at opposite ends, each with low enough magnitude to pass the terminal gaps without sparkover. When voltage surges occur simultaneously at each end of a line and travel toward each other, the total voltage on the line at the point where they meet is the arithmetic sum of the two surges. A gap installed within 0.8 km (0.5 mile) of the worksite will protect against such intersecting waves. Engineering studies of a particular line or system may indicate that employers can adequately protect employees by installing gaps at even more distant locations. In any event, unless using the default values for T from Table 2940.2-5, the employer shall determine T at the worksite.

3. *Worksite.* If the employer installs protective gaps at the worksite, the gap setting establishes the worksite impulse insulation strength. Lightning strikes as far as 6 miles from the worksite can 1cause a voltage surge greater than the gap withstand voltage, and a gap sparkover can occur. In addition, the gap can sparkover from overvoltages on the line that exceed the withstand voltage of the gap. Consequently, the employer shall protect employees from hazards resulting from any sparkover that could occur.

F. *Disabling automatic reclosing.* There are two reasons to disable the automatic-reclosing feature of circuit-interrupting devices while employees are performing live-line work:

- To prevent reenergization of a circuit faulted during the work, which could create a hazard or result in more serious injuries or damage than the injuries or damage produced by the original fault;

- To prevent any transient overvoltage caused by the switching surge that would result if the circuit were reenergized. However, due to system stability considerations, it may not always be feasible to disable the automatic-reclosing feature.

V. Minimum Approach-Distance Tables

A. *Legacy tables.* Employers may use the minimum approach distances in Table 6 through Table 13 until [**OAL will insert this date to be six months from the effective date of the regulation**].

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TABLE 6-MINIMUM APPROACH DISTANCES UNTIL
[OAL will insert this date to be six months from the effective date of the regulation]

Voltage range phase to phase (kV)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
0.05 to 1.0	Avoid Contact		Avoid Contact	
1.1 to 15.0	0.64	2.10	0.66	2.20
15.1 to 36.0	0.72	2.30	0.77	2.60
36.1 to 46.0	0.77	2.60	0.85	2.80
46.1 to 72.5	0.90	3.00	1.05	3.50
72.6 to 121	0.95	3.20	1.29	4.30
138 to 145	1.09	3.60	1.50	4.90
161 to 169	1.22	4.00	1.71	5.70
230 to 242	1.59	5.30	2.27	7.50
345 to 362	2.59	8.50	3.80	12.50
500 to 550	3.42	11.30	5.50	18.10
765 to 800	4.53	14.90	7.91	26.00

Note: The clear live-line tool distance must equal or exceed the values for the indicated voltage ranges.

TABLE 7-MINIMUM APPROACH DISTANCES UNTIL
[OAL will insert this date to be six months from the effective date of the regulation], 72.6 TO 121.0 kV WITH OVERVOLTAGE FACTOR

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
2.0	0.74	2.42	1.09	3.58
2.1	0.76	2.50	1.09	3.58
2.2	0.79	2.58	1.12	3.67
2.3	0.81	2.67	1.14	3.75
2.4	0.84	2.75	1.17	3.83
2.5.	0.84	2.75	1.19	3.92
2.6	0.86	2.83	1.22	4.00
2.7	0.89	2.92	1.24	4.08
2.8	0.91	3.00	1.24	4.08
2.9	0.94	3.08	1.27	4.17
3.0	0.97	3.17	1.30	4.25

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Note 1: The employer may apply the distance specified in this table only where the employer determines the maximum anticipated per-unit transient overvoltage by engineering analysis. (Table 6 applies otherwise.)

Note 2: The distances specified in this table are the air, bare-hand, and live-line tool distances.

TABLE 8-MINIMUM APPROACH DISTANCES UNTIL [OAL will insert this date to be six months from the effective date of the regulation], 121.1 TO 145.0 kV WITH OVERVOLTAGE FACTOR

T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
2.0	0.84	2.75	1.24	4.08
2.1	0.86	2.83	1.27	4.17
2.2	0.89	2.92	1.30	4.25
2.3	0.91	3.00	1.32	4.33
2.4	0.94	3.08	1.35	4.42
2.5	0.97	3.17	1.37	4.50
2.6	0.99	3.25	1.40	4.58
2.7	1.02	3.33	1.42	4.67
2.8	1.04	3.42	1.45	4.75
2.9	1.07	3.50	1.47	4.83
3.0	1.09	3.58	1.50	4.92

Note 1: The employer may apply the distance specified in this table only where the employer determines the maximum anticipated per-unit transient overvoltage by engineering analysis. (Table 6 applies otherwise.)

Note 2: The distances specified in this table are the air, bare-hand, and live-line tool distances.

TABLE 9-MINIMUM APPROACH DISTANCES UNTIL [OAL will insert this date to be six months from the effective date of the regulation], 145.1 TO 169.0 kV WITH OVERVOLTAGE FACTOR

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
2.0	0.91	3.00	1.42	4.67
2.1 .	0.97	3.17	1.45	4.75

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2.2	0.99	3.25	1.47	4.83
2.3	1.02	3.33	1.50	4.92
2.4	1.04	3.42	1.52	5.00
2.5	1.07	3.50	1.57	5.17
2.6	1.12	3.67	1.60	5.25
2.7	1.14	3.75	1.63	5.33
2.8	1.17	3.83	1.65	5.42
2.9	1.19	3.92	1.68	5.50
3.0	1.22	4.00	1.73	5.67

Note 1: The employer may apply the distance specified in this table only where the employer determines the maximum anticipated per-unit transient overvoltage by engineering analysis. (Table 6 applies otherwise.)

Note 2: The distances specified in this table are the air, bare-hand, and live-line tool distances.

TABLE 10-MINIMUM APPROACH DISTANCES UNTIL [OAL will insert this date to be six months from the effective date of the regulation], 169.1 TO 242.0 kV WITH OVERVOLTAGE FACTOR

T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
2.0	1.17	3.83	1.85	6.08
2.1	1.22	4.00	1.91	6.25
2.2	1.24	4.08	1.93	6.33
2.3	1.30	4.25	1.98	6.50
2.4	1.35	4.42	2.01	6.58
2.5	1.37	4.50	2.06	6.75
2.6	1.42	4.67	2.11	6.92
2.7.	1.47	4.83	2.13	7.00
2.8	1.50	4.92	2.18	7.17
2.9	1.55	5.08	2.24	7.33
3.0	1.60	5.25	2.29	7.50

Note 1: The employer may apply the distance specified in this table only where the employer determines the maximum anticipated per-unit transient overvoltage by engineering analysis. (Table 6 applies otherwise.)

Note 2: The distances specified in this table are the air, bare-hand, and live-line tool distances.

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TABLE 11-MINIMUM APPROACH DISTANCES UNTIL
[OAL will insert this date to be six months from the effective date of the regulation],
242.1 TO 362.0 kV WITH OVERVOLTAGE FACTOR

T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
2.0	1.60	5.25	2.62	8.58
2.1	1.65	5.42	2.69	8.83
2.2	1.75	5.75	2.79	9.17
2.3	1.85	6.08	2.90	9.50
2.4	1.93	6.33	3.02	9.92
2.5	2.03	6.67	3.15	10.33
2.6	2.16	7.08	3.28	10.75
2.7 .	2.26	7.42	3.40	11.17
2.8	2.36	7.75	3.53	11.58
2.9	2.49	8.17	3.68	12.08
3.0	2.59	8.50	3.81	12.50

Note 1: The employer may apply the distance specified in this table only where the employer determines the maximum anticipated per-unit transient overvoltage by engineering analysis. (Table 6 applies otherwise.)

Note 2: The distances specified in this table are the air, bare-hand, and live-line tool distances.

TABLE 12-MINIMUM APPROACH DISTANCES UNTIL
[OAL will insert this date to be six months from the effective date of the regulation],
362.1 TO 552.0 kV WITH OVERVOLTAGE FACTOR

T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	1.83	6.00	2.24	7.33
1.6	1.98	6.50	2.67	8.75
1.7	2.13	7.00	3.10	10.17
1.8	2.31	7.58	3.53	11.58
1.9	2.46	8.08	4.01	13.17
2.0	2.67	8.75	4.52	14.83
2.1	2.84	9.33	4.75	15.58

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2.2	3.02	9.92	4.98	16.33
2.3	3.20	10.50	5.23	17.17
2.4	3.43	11.25	5.51	18.08

Note 1: The employer may apply the distance specified in this table only where the employer determines the maximum anticipated per-unit transient overvoltage by engineering analysis. (Table 6 applies otherwise.)

Note 2: The distances specified in this table are the air, bare-hand, and live-line tool distances.

TABLE 13-MINIMUM APPROACH DISTANCES UNTIL [OAL will insert this date to be six months from the effective date of the regulation], 552.1 TO 800.0 kV WITH OVERVOLTAGE FACTOR				
T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	2.95	9.67	3.68	12.08
1.6	3.25	10.67	4.42	14.50
1.7	3.56	11.67	5.23	17.17
1.8	3.86	12.67	6.07	19.92
1.9	4.19	13.75	6.99	22.92
2.0	4.55	14.92	7.92	26.00

Note 1: The employer may apply the distance specified in this table only where the employer determines the maximum anticipated per-unit transient overvoltage by engineering analysis. (Table 6 applies otherwise.)

Note 2: The distances specified in this table are the air, bare-hand, and live-line tool distances.

B. *Alternative minimum approach distances*. Employers may use the minimum approach distances in Table 14 through Table 21 provided that the employer follows the notes to those tables.

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TABLE 14-AC MINIMUM APPROACH DISTANCES-72.6 TO 121.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	0.67	2.2	0.84	2.8
1.6	0.69	2.3	0.87	2.9
1.7	0.71	2.3	0.90	3.0
1.8	0.74	2.4	0.93	3.1
1.9	0.76	2.5	0.96	3.1
2.0	0.78	2.6	0.99	3.2
2.1	0.81	2.7	1.01	3.3
2.2	0.83	2.7	1.04	3.4
2.3	0.85	2.8	1.07	3.5
2.4	0.88	2.9	1.10	3.6
2.5	0.90	3.0	1.13	3.7
2.6	0.92	3.0	1.16	3.8
2.7	0.95	3.1	1.19	3.9
2.8	0.97	3.2	1.22	4.0

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2.9	0.99	3.2	1.24	4.1
3.0	1.02	3.3	1.27	4.2
3.1	1.04	3.4	1.30	4.3
3.2	1.06	3.5	1.33	4.4
3.3	1.09	3.6	1.36	4.5
3.4	1.11	3.6	1.39	4.6
3.5	1.13	3.7	1.42	4.7

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TABLE 15-AC MINIMUM APPROACH DISTANCES-121.1 TO 145.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	0.74	2.4	0.95	3.1
1.6	0.76	2.5	0.98	3.2
1.7	0.79	2.6	1.02	3.3
1.8	0.82	2.7	1.05	3.4
1.9	0.85	2.8	1.08	3.5
2.0	0.88	2.9	1.12	3.7
2.1	0.90	3.0	1.15	3.8
2.2	0.93	3.1	1.19	3.9
2.3	0.96	3.1	1.22	4.0
2.4	0.99	3.2	1.26	4.1
2.5	1.02	3.3	1.29	4.2
2.6	1.04	3.4	1.33	4.4
2.7	1.07	3.5	1.36	4.5

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2.8	1.10	3.6	1.39	4.6
2.9	1.13	3.7	1.43	4.7
3.0	1.16	3.8	1.46	4.8
3.1	1.19	3.9	1.50	4.9
3.2	1.21	4.0	1.53	5.0
3.3	1.24	4.1	1.57	5.2
3.4	1.27	4.2	1.60	5.2
3.5	1.30	4.3	1.64	5.4

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TABLE 16-AC MINIMUM APPROACH DISTANCES-145.1 TO 169.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	0.81	2.7	1.05	3.4
1.6	0.84	2.8	1.09	3.6
1.7	0.87	2.9	1.13	3.7
1.8	0.90	3.0	1.17	3.8
1.9	0.94	3.1	1.21	4.0
2.0	0.97	3.2	1.25	4.1
2.1	1.00	3.3	1.29	4.2
2.2	1.03	3.4	1.33	4.4
2.3	1.07	3.5	1.37	4.5
2.4	1.10	3.6	1.41	4.6
2.5	1.13	3.7	1.45	4.8
2.6	1.17	3.8	1.49	4.9
2.7	1.20	3.9	1.53	5.0
2.8	1.23	4.0	1.57	5.2

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2.9	1.26	4.1	1.61	5.3
3.0	1.30	4.3	1.65	5.4
3.1	1.33	4.4	1.70	5.6
3.2	1.36	4.5	1.76	5.8
3.3.	1.39	4.6	1.82	6.0
3.4	1.43	4.7	1.88	6.2
3.5	1.46	4.8	1.94	6.4

TABLE 17-AC MINIMUM APPROACH DISTANCES-169.1 TO 242.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	1.02	3.3	1.37	4.5
1.6	1.06	3.5	1.43	4.7
1.7	1.11	3.6	1.48	4.9
1.8	1.16	3.8	1.54	5.1
1.9	1.21	4.0	1.60	5.2
2.0	1.25	4.1	1.66	5.4
2.1	1.30	4.3	1.73	5.7

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2.2	1.35	4.4	1.81	5.9
2.3	1.39	4.6	1.90	6.2
2.4	1.44	4.7	1.99	6.5
2.5	1.49	4.9	2.08	6.8
2.6	1.53	5.0	2.17	7.1
2.7	1.58	5.2	2.26	7.4
2.8	1.63	5.3	2.36	7.7
2.9	1.67	5.5	2.45	8.0
3.0	1.72	5.6	2.55	8.4
3.1	1.77	5.8	2.65	8.7
3.2	1.81	5.9	2.76	9.1
3.3	1.88	6.2	2.86	9.4
3.4	1.95	6.4	2.97	9.7
3.5	2.01	6.6	3.08	10.1

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TABLE 18-AC MINIMUM APPROACH DISTANCES-242.1 TO 362.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	1.37	4.5	1.99	6.5
1.6	1.44	4.7	2.13	7.0
1.7	1.51	5.0	2.27	7.4
1.8	1.58	5.2	2.41	7.9
1.9	1.65	5.4	2.56	8.4
2.0	1.72	5.6	2.71	8.9
2.1	1.79	5.9	2.87	9.4
2.2	1.87	6.1	3.03	9.9
2.3	1.97	6.5	3.20	10.5
2.4	2.08	6.8	3.37	11.1
2.5	2.19	7.2	3.55	11.6
2.6	2.29	7.5	3.73	12.2
2.7	2.41	7.9	3.91	12.8
2.8	2.52	8.3	4.10	13.5

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2.9	2.64	8.7	4.29	14.1
3.0	2.76	9.1	4.49	14.7
3.1	2.88	9.4	4.69	15.4
3.2	3.01	9.9	4.90	16.1
3.3	3.14	10.3	5.11	16.8
3.4	3.27	10.7	5.32	17.5
3.5	3.41	11.2	5.52	18.1

TABLE 19-AC MINIMUM APPROACH DISTANCES-362.1 TO 420.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	1.53	5.0	2.40	7.9
1.6	1.62	5.3	2.58	8.5
1.7	1.70	5.6	2.75	9.0
1.8	1.78	5.8	2.94	9.6
1.9	1.88	6.2	3.13	10.3
2.0	1.99	6.5	3.33	10.9

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2.1	2.12	7.0	3.53	11.6
2.2	2.24	7.3	3.74	12.3
2.3	2.37	7.8	3.95	13.0
2.4	2.50	8.2	4.17	13.7
2.5.	2.64	8.7	4.40	14.4
2.6.	2.78	9.1	4.63	15.2
2.7	2.93	9.6	4.87	16.0
2.8	3.07	10.1	5.11	16.8
2.9	3.23	10.6	5.36	17.6
3..0	3.38	11.1	5.59	18.3
3.1.	3.55	11.6	5.82	19.1
3.2	3.72	12.2	6.07	19.9
3.3	3.89	12.8	6.31	20.7
3.4	4.07	13.4	6.56	21.5
3.5	4.25	13.9	6.81	22.3

TABLE 20-AC MINIMUM APPROACH DISTANCES-420.1 TO 550.0 KV

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T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	1.95	6.4	3.46	11.4
1.6	2.11	6.9	3.73	12.2
1.7	2.28	7.5	4.02	13.2
1.8	2.45	8.0	4.31	14.1
1.9	2.62	8.6	4.61	15.1
2.0	2.81	9.2	4.92	16.1
2.1	3.00	9.8	5.25	17.2
2.2	3.20	10.5	5.55	18.2
2.3	3.40	11.2	5.86	19.2
2.4	3.62	11.9	6.18	20.3
2.5	3.84	12.6	6.50	21.3
2.6	4.07	13.4	6.83	22.4
2.7	4.31	14.1	7.18	23.6
2.8	4.56	15.0	7.52	24.7
2.9	4.81	15.8	7.88	25.9

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3.0	5.07	16.6	8.24	27.0

TABLE 21-AC MINIMUM APPROACH DISTANCES-550.1 TO 800.0 KV				
T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	3.16	10.4	5.97	19.6
1.6	3.46	11.4	6.43	21.1
1.7	3.78	12.4	6.92	22.7
1.8	4.12	13.5	7.42	24.3
1.9	4.47	14.7	7.93	26.0
2.0	4.83	15.8	8.47	27.8
2.1	5.21	17.1	9.02	29.6
2.2	5.61	18.4	9.58	31.4
2.3	6.02	19.8	10.16	33.3
2.4	6.44	21.1	10.76	35.3
2.5	6.88	22.6	11.38	37.3

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Notes to Table 14 through Table 21:

1. The employer must determine the maximum anticipated per-unit transient overvoltage, phase-to-ground, through an engineering analysis, as required by § 1910.269(l)(3)(ii), or assume a maximum anticipated per-unit transient overvoltage, phase-to-ground, in accordance with Table R-9.
2. For phase-to-phase exposures, the employer must demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap.
3. The worksite must be at an elevation of 900 meters (3,000 feet) or less above sea level.

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[1] Federal, State, and local regulatory bodies and electric utilities set reliability requirements that limit the number and duration of system outages.
[2] Sparkover is a disruptive electric discharge in which an electric arc forms and electric current passes through air.
[3] The withstand voltage is the voltage at which sparkover is not likely to occur across a specified distance. It is the voltage taken at the 3s point below the sparkover voltage, assuming that the sparkover curve follows a normal distribution.
[4] Test data demonstrates that the saturation factor is greater than 0 at peak voltages of about 630 kilovolts. Systems operating at 345 kilovolts (or maximum system voltages of 362 kilovolts) can have peak maximum transient overvoltages exceeding 630 kilovolts. Table R-3 sets equations for calculating a based on peak voltage.
[5] For voltages of 50 to 300 volts, Table R-3 specifies a minimum approach distance of "avoid contact." The minimum approach distance for this voltage range contains neither an electrical component nor an ergonomic component.
[6] For the purposes of estimating arc length, § 1910.269 generally assumes a more conservative dielectric strength of 10 kilovolts per 25.4 millimeters, consistent with assumptions made in consensus standards such as the National Electrical Safety Code (IEEE C2-2012). The more conservative value accounts for variables such as electrode shape, wave shape, and a certain amount of overvoltage.
[7] The detailed design of a circuit interrupter, such as the design of the contacts, resistor insertion, and breaker timing control, are beyond the scope of this appendix. The design of the system generally accounts for these features. This appendix only discusses features that can limit the maximum switching transient overvoltage on a system.
[8] Surge arrester application is beyond the scope of this appendix. However, if the employer installs the arrester near the work site, the application would be similar to the protective gaps discussed in paragraph IV.D of this appendix.
[9] The employer should check the withstand voltage to ensure that it results in a probability of gap flashover that is acceptable from a system outage perspective. (In other words, a gap sparkover

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will produce a system outage. The employer should determine whether such an outage will impact overall system performance to an acceptable degree.) In general, the withstand voltage should be at least 1.25 times the maximum crest operating voltage.

[10] The manufacturer of the gap provides, based on test data, the critical sparkover voltage for each gap spacing (for example, a critical sparkover voltage of 665 kilovolts for a gap spacing of 1.2 meters). The withstand voltage for the gap is equal to 85 percent of its critical sparkover voltage.

[11] Switch steps 1 and 2 if the length of the protective gap is known.

[12] IEEE Std 516-2009 states that most employers add 0.2 to the calculated value of T as an additional safety factor.

[13] To eliminate sparkovers due to minor system disturbances, the employer should use a withstand voltage no lower than 1.25 p.u. Note that this is a practical, or operational, consideration only. It may be feasible for the employer to use lower values of withstand voltage.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Amend Appendix C to Article 36 to read:

Appendix C

PROTECTIVE EQUIPMENT

Insulating equipment shall meet the marking, inspection, performance and testing provisions of the American Society for Testing and Materials (ASTM), which is hereby incorporated by reference, as follows:

ITEM ASTM STANDARD

Standard Specification for Rubber Insulating Gloves	~~D 120-02a -(Reapproved 2006)~~ D120-09
Standard Specification for Rubber Insulating Matting	~~D 178-01) (Reapproved 2005)~~ D178-01 (2010)
Standard Specification for Rubber Insulating Blankets	~~D 1048-05~~ D1048-12
Standard Specification for Rubber Insulating Covers	~~D 1049-98 (Reapproved 2002)~~ D1049-98 (2010)
Standard Specification for Rubber Insulating Line Hose	~~D 1050-05~~ D1050-05 (2011)
Standard Specification for Rubber Insulating Sleeves	~~D 1051-06~~ D1051-08
Leather Protectors for Rubber Insulating Gloves and Mittens	~~F 696-~~F696-06 (2011)
~~Insulating Plastic Guard Equipment~~ Standard Test Methods and Specifications for Electrically Insulating Plastic Guard Equipment for Protection of Workers	~~F 968-93 (Reapproved 2002)~~ F712–06 (2011)
Insulating Work Platforms for Electrical Workers	F 1564-95 (Reapproved 2006)
Standard Guide for Visual Inspection of Electrical Protective Rubber Products	F1236-96 (2012)
Standard Specification for In-Service Care of Insulating Line Hose and Covers	F478–09
Standard Specification for In-Service Care of Insulating Blankets	F479–06 (2011)
Standard Specification for In-Service Care of Insulating Gloves and Sleeves	F496–08
Standard Terminology Relating to Electrical Protective Equipment for Workers, includes definitions of terms relating to the electrical protective equipment covered under	F819–10

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this section.	

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Add new Appendix D to Article 36 to read:

Appendix D

PROTECTION FROM FLAMES AND ELECTRIC ARCS

I. Introduction

Section 2940.11 addresses protecting employees from flames and electric arcs. This section requires employers to: (1) Assess the workplace for flame and electric-arc hazards; (2) estimate the available heat energy from electric arcs to which employees would be exposed; (3) ensure that employees wear clothing that will not melt, or ignite and continue to burn, when exposed to flames or the estimated heat energy; and (4) ensure that employees wear flame-resistant clothing[1] and protective clothing and other protective equipment that has an arc rating greater than or equal to the available heat energy under certain conditions. This appendix contains information to help employers estimate available heat energy, select protective clothing and other protective equipment with an arc rating suitable for the available heat energy, and ensure that employees do not wear flammable clothing that could lead to burn injury.

II. Assessing the Workplace for Flame and Electric-Arc Hazards

Section 2940.11(a)(1) requires the employer to assess the workplace to identify employees exposed to hazards from flames or from electric arcs. This provision ensures that the employer evaluates employee exposure to flames and electric arcs so that employees who face such exposures receive the required protection. The employer shall conduct an assessment for each employee who performs work on or near exposed, energized parts of electric circuits.

A. *Assessment Guidelines*
Sources electric arcs. Consider possible sources of electric arcs, including:

- Energized circuit parts not guarded or insulated,
- Switching devices that produce electric arcs in normal operation,
- Sliding parts that could fault during operation (for example, rack-mounted circuit breakers), and
- Energized electric equipment that could fail (for example, electric equipment with damaged insulation or with evidence of arcing or overheating).

Exposure to flames. Identify employees exposed to hazards from flames. Factors to consider include:

- The proximity of employees to open flames, and
- For flammable material in the work area, whether there is a reasonable likelihood that an

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electric arc or an open flame can ignite the material.

Probability that an electric arc will occur. Identify employees exposed to electric-arc hazards. The Division of Occupational Safety and Health will consider an employee exposed to electric-arc hazards if there is a reasonable likelihood that an electric arc will occur in the employee's work area, in other words, if the probability of such an event is higher than it is for the normal operation of enclosed equipment. Factors to consider include:

- For energized circuit parts not guarded or insulated, whether conductive objects can come too close to or fall onto the energized parts,
- For exposed, energized circuit parts, whether the employee is closer to the part than the minimum approach distance established by the employer (as permitted by Section 2940.2)
- Whether the operation of electric equipment with sliding parts that could fault during operation is part of the normal operation of the equipment or occurs during servicing or maintenance, and
- For energized electric equipment, whether there is evidence of impending failure, such as evidence of arcing or overheating.

B. *Examples*

Table 1 provides task-based examples of exposure assessments.

TABLE 1-EXAMPLE ASSESSMENTS FOR VARIOUS TASKS

Task		Is employee exposed to flame or electric arc hazard?
Normal operation of enclosed equipment, such as closing or opening a switch.	The employer properly installs and maintains enclosed equipment, and there is no evidence of impending failure.	No.
	There is evidence of arcing or overheating	Yes.
	Parts of the equipment are loose or sticking, or the equipment otherwise exhibits signs of lack of maintenance.	Yes.
Servicing electric equipment, such as racking in a circuit breaker or replacing a switch		Yes.
Inspection of electric equipment with exposed	The employee is not holding conductive objects and remains outside the minimum approach distance	No.

energized parts.	established by the employer.	
	The employee is holding a conductive object, such as a flashlight, that could fall or otherwise contact energized parts (irrespective of whether the employee maintains the minimum approach distance).	Yes.
	The employee is closer than the minimum approach distance established by the employer (for example, when wearing rubber insulating gloves or rubber insulating gloves and sleeves).	Yes.
Using open flames, for example, in wiping cable splice sleeves.		Yes.

III. Protection Against Burn Injury

A. *Estimating Available Heat Energy*
Calculation methods. Subsection (a)(2) of Section 2940.11 provides that, for each employee exposed to an electric-arc hazard, the employer shall make a reasonable estimate of the heat energy to which the employee would be exposed if an arc occurs. Table 2 lists various methods of calculating values of available heat energy from an electric circuit. The Division of Occupational Safety and Health does not endorse any of these specific methods. Each method requires the input of various parameters, such as fault current, the expected length of the electric arc, the distance from the arc to the employee, and the clearing time for the fault (that is, the time the circuit protective devices take to open the circuit and clear the fault). The employer can precisely determine some of these parameters, such as the fault current and the clearing time, for a given system. The employer will need to estimate other parameters, such as the length of the arc and the distance between the arc and the employee, because such parameters vary widely.

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TABLE 2-METHODS OF CALCULATING INCIDENT HEAT ENERGY FROM AN ELECTRIC ARC
1. Standard for Electrical Safety Requirements for Employee Workplaces, NFPA 70E-2012, Annex D, "Sample Calculation of Flash Protection Boundary." 2. Doughty, T.E., Neal, T.E., and Floyd II, H.L., "Predicting Incident Energy to Better Manage the Electric Arc Hazard on 600 V Power Distribution Systems," Record of Conference Papers IEEE IAS 45th Annual Petroleum and Chemical Industry Conference, September 28-30, 1998. 3. Guide for Performing Arc-Flash Hazard Calculations, IEEE Std 1584-2002, 1584a-2004 (Amendment 1 to IEEE Std 1584-2002), and 1584b-2011 (Amendment 2: Changes to Clause 4 of IEEE Std 1584-2002).* 4. ARCPRO, a commercially available software program developed by Kinectrics, Toronto, ON, CA.

* This appendix refers to IEEE Std 1584-2002 with both amendments as IEEE Std 1584b-2011.

The amount of heat energy calculated by any of the methods is approximately inversely proportional to the square of the distance between the employee and the arc. In other words, if the employee is very close to the arc, the heat energy is very high; but if the employee is just a few more centimeters away, the heat energy drops substantially. Thus, estimating the distance from the arc to the employee is key to protecting employees.

The employer shall select a method of estimating incident heat energy that provides a reasonable estimate of incident heat energy for the exposure involved. Table 3 shows which methods provide reasonable estimates for various exposures.

TABLE 3-SELECTING A REASONABLE INCIDENT-ENERGY CALCULATION METHOD [1]

Incident-energy calculation method	600 V and Less [2]			601 V to 15 kV [2]			More than 15 kV		
	1Φ	3Φa	3Φb	1Φ	3Φa	3Φb	1Φ	3Φa	3Φb
NFPA 70E-2012 Annex D (Lee equation)	Y-C	Y	N	Y-C	Y-C	N	N[3]	N[3]	N[3]
Doughty, Neal, and Floyd	Y-C	Y	Y	N	N	N	N	N	N
IEEE Std 1584b-2011	Y	Y	Y	Y	Y	Y	N	N	N
ARCPRO	Y	N	N	Y	N	N	Y	Y[4]	Y[4]

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Key:
1Φ: Single-phase arc in open air.
3Φa: Three-phase arc in open air.
3Φb: Three-phase arc in an enclosure (box).
Y: Acceptable; produces a reasonable estimate of incident heat energy from this type of electric arc.
N: Not acceptable; does not produce a reasonable estimate of incident heat energy from this type of electric arc.
Y-C: Acceptable; produces a reasonable, but conservative, estimate of incident heat energy from this type of electric arc.

NOTES:
[1] Although the Division of Occupational Safety and Health will consider these methods reasonable for enforcement purposes when employers use the methods in accordance with this table, employers should be aware that the listed methods do not necessarily result in estimates that will provide full protection from internal faults in transformers and similar equipment or from arcs in underground manholes or vaults.
[2] At these voltages, the presumption is that the arc is three-phase unless the employer can demonstrate that only one phase is present or that the spacing of the phases is sufficient to prevent a multiphase arc from occurring.
[3]Although the Division of Occupational Safety and Health will consider this method acceptable for purposes of assessing whether incident energy exceeds 2.0 cal/cm^2, the results at voltages of more than 15 kilovolts are extremely conservative and unrealistic.
[4] The Division of Occupational Safety and Health will deem the results of this method reasonable when the employer adjusts them using the conversion factors for three-phase arcs in open air or in an enclosure, as indicated in the program's instructions.

Selecting a reasonable distance from the employee to the arc. In estimating available heat energy, the employer shall make some reasonable assumptions about how far the employee will be from the electric arc. Table 4 lists reasonable distances from the employee to the electric arc. The distances in Table 4 are consistent with national consensus standards, such as the Institute of Electrical and Electronic Engineers' National Electrical Safety Code, ANSI/IEEE C2-2012, and IEEE Guide for Performing Arc-Flash Hazard Calculations, IEEE Std 1584b-2011. The employer is free to use other reasonable distances, but shall consider equipment enclosure size and the working distance to the employee in selecting a distance from the employee to the arc. The Division of Occupational Safety and Health will consider a distance reasonable when the employer bases it on equipment size and working distance.

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TABLE 4-SELECTING A REASONABLE DISTANCE FROM THE EMPLOYEE TO THE ELECTRIC ARC

Class of equipment	Single-phase arc mm (inches)	Three-phase arc mm (inches)
Cable	NA*	455 (18)
Low voltage MCCs and panelboards	NA	455 (18)
Low-voltage switchgear	NA	610 (24)
5-kV switchgear	NA	910 (36)
15-kV switchgear	NA	910 (36)
Single conductors in air (up to 46 kilovolts), work with rubber insulating gloves	380 (15)	NA
Single conductors in air, work with live-line tools and live-line barehand work	MAD - (2 × kV × 2.54) (MAD - (2 × kV /10)) †	NA

* NA = not applicable.
† The terms in this equation are:
MAD = The applicable minimum approach distance, and
kV = The system voltage in kilovolts.

Selecting a reasonable arc gap. For a single-phase arc in air, the electric arc will almost always occur when an energized conductor approaches too close to ground. Thus, an employer can determine the arc gap, or arc length, for these exposures by the dielectric strength of air and the voltage on the line. The dielectric strength of air is approximately 10 kilovolts for every 25.4 millimeters (1 inch). For example, at 50 kilovolts, the arc gap would be 50 ÷ 10 × 25.4 (or 50 × 2.54), which equals 127 millimeters (5 inches).

For three-phase arcs in open air and in enclosures, the arc gap will generally be dependent on the spacing between parts energized at different electrical potentials. Documents such as IEEE Std 1584b-2011 provide information on these distances. Employers may select a reasonable arc gap from Table 5, or they may select any other reasonable arc gap based on sparkover distance or on the spacing between (1) live parts at different potentials or (2) live parts and grounded parts (for example, bus or conductor spacings in equipment). In any event, the employer shall use an estimate that reasonably resembles the actual exposures faced by the employee.

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TABLE 5-SELECTING A REASONABLE ARC GAP

Class of equipment	Single-phase arc mm (inches)	Three-phase arc mm [1] (inches)
Cable	NA[2]	13 (0.5)
Low voltage MCCs and panelboards	NA	25 (1.0)
Low-voltage switchgear.	NA	32 (1.25)
5-kV switchgear	NA	104 (4.0)
15-kV switchgear	NA	152 (6.0)
Single conductors in air, 15 kV and less.	51 (2.0)	Phase conductor spacing.
Single conductor in air, more than 15 kV	Voltage in kV × 2.54 (Voltage in kV × 0.1), but no less than 51 mm (2 inches).	Phase conductor spacing.

[1] Source: IEEE Std 1584b-2011.
[2] NA = not applicable.

Making estimates over multiple system areas. The employer need not estimate the heat-energy exposure for every job task performed by each employee. Subsection (a)(2) of Section 2940.11 permits the employer to make broad estimates that cover multiple system areas provided that: (1) The employer uses reasonable assumptions about the energy-exposure distribution throughout the system, and (2) the estimates represent the maximum exposure for those areas. For example, the employer can use the maximum fault current and clearing time to cover several system areas at once.

Incident heat energy for single-phase-to-ground exposures. Table 6 and Table 7 provide incident heat energy levels for open air, phase-to-ground electric-arc exposures typical for overhead systems.[2] Table 6 presents estimates of available energy for employees using rubber insulating gloves to perform work on overhead systems operating at 4 to 46 kilovolts. The table assumes that the employee will be 380 millimeters (15 inches) from the electric arc, which is a reasonable estimate for rubber insulating glove work. Table 6 also assumes that the arc length equals the sparkover distance for the maximum transient overvoltage of each voltage range.[3] To use the table, an employer would use the voltage, maximum fault current, and maximum clearing time for a system area and, using the appropriate voltage range and fault-current and clearing time values corresponding to the next higher values listed in the table, select the appropriate heat

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energy (4, 5, 8, or 12 cal/cm^2) from the table. For example, an employer might have a 12,470-volt power line supplying a system area. The power line can supply a maximum fault current of 8 kiloamperes with a maximum clearing time of 10 cycles. For rubber glove work, this system falls in the 4.0-to-15.0-kilovolt range; the next-higher fault current is 10 kA (the second row in that voltage range); and the clearing time is under 18 cycles (the first column to the right of the fault current column). Thus, the available heat energy for this part of the system will be 4 cal/cm^2 or less (from the column heading), and the employer could select protection with a 5-cal/cm^2 rating to meet Section 2940.11(b)(2). Alternatively, an employer could select a base incident-energy value and ensure that the clearing times for each voltage range and fault current listed in the table do not exceed the corresponding clearing time specified in the table. For example, an employer that provides employees with arc-flash protective equipment rated at 8 cal/cm^2 can use the table to determine if any system area exceeds 8 cal/cm^2 by checking the clearing time for the highest fault current for each voltage range and ensuring that the clearing times do not exceed the values specified in the 8-cal/cm^2 column in the table.

Table 7 presents similar estimates for employees using live-line tools to perform work on overhead systems operating at voltages of 4 to 800 kilovolts. The table assumes that the arc length will be equal to the sparkover distance[4] and that the employee will be a distance from the arc equal to the minimum approach distance minus twice the sparkover distance.

The employer will need to use other methods for estimating available heat energy in situations not addressed by Table 6 or Table 7. The calculation methods listed in Table 2 and the guidance provided in Table 3 will help employers do this. For example, employers can use IEEE Std 1584b-2011 to estimate the available heat energy (and to select appropriate protective equipment) for many specific conditions, including lower voltage, phase-to-phase arc, and enclosed arc exposures.

TABLE 6-INCIDENT HEAT ENERGY FOR VARIOUS FAULT CURRENTS, CLEARING TIMES, AND VOLTAGES OF 4.0 TO 46.0 kV: RUBBER INSULATING GLOVE EXPOSURES INVOLVING PHASE-TO-GROUND ARCS IN OPEN AIR ONLY * † ‡

Voltage range (kV) **	Fault current (kA)	Maximum clearing time (cycles)			
		4 cal/cm^2	5 cal/cm^2	8 cal/cm^2	12 cal/cm^2
4.0 to 15.0	5	46	58	92	138
	10	18	22	36	54
	15	10	12	20	30
	20	6	8	13	19
15.1 to 25.0	5	28	34	55	83
	10	11	14	23	34

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	15	7	8	13	20
	20	4	5	9	13
25.1 to 36.0	5	21	26	42	62
	10	9	11	18	26
	15	5	6	10	16
	20	4	4	7	11
36.1 to 46.0.	5	16	20	32	48
	10	7	9	14	21
	15	4	5	8	13
	20	3	4	6	9

NOTES:
* This table is for open-air, phase-to-ground electric-arc exposures. It is not for phase-to-phase arcs or enclosed arcs (arc in a box).
† The table assumes that the employee will be 380 mm (15 in.) from the electric arc. The table also assumes the arc length to be the sparkover distance for the maximum transient overvoltage of each voltage range (see Appendix A), as follows:

4.0 to 15.0 kV   51 mm (2 in.)
15.1 to 25.0 kV   102 mm (4 in.)
25.1 to 36.0 kV   152 mm (6 in.)
36.1 to 46.0 kV   229 mm (9 in.)

‡ The Department of Labor, Occupational Safety and Health Administration calculated the values in this table using the ARCPRO method listed in Table 2.
** The voltage range is the phase-to-phase system voltage.

TABLE 7-INCIDENT HEAT ENERGY FOR VARIOUS FAULT CURRENTS, CLEARING TIMES, AND VOLTAGES: LIVE-LINE TOOL EXPOSURES INVOLVING PHASE-TO-GROUND ARCS IN OPEN AIR ONLY * † ‡ #

Voltage range (kV) **	Fault current (kA)	Maximum clearing time (cycles)			
		4 cal/cm^2	5 cal/cm^2	8 cal/cm^2	12 cal/cm^2
4.0 to 15.0	5	197	246	394	591
	10	73	92	147	220
	15	39	49	78	117
	20	24	31	49	73
15.1 to 25.0	5	197	246	394	591
	10	75	94	150	225
	15	41	51	82	122

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	20	26	33	52	78
25.1 to 36.0	5	138	172	275	413
	10	53	66	106	159
	15	30	37	59	89
	20	19	24	38	58
36.1 to 46.0	5	129	161	257	386
	10	51	64	102	154
	15	29	36	58	87
	20	19	24	38	57
46.1 to 72.5	20	18	23	36	55
	30	10	13	20	30
	40	6	8	13	19
	50	4	6	9	13
72.6 to 121.0	20	10	12	20	30
	30	6	7	11	17
	40	4	5	7	11
	50	3	3	5	8
121.1 to 145.0	20	12	15	24	35
	30	7	9	15	22
	40	5	6	10	15
	50	4	5	8	11
145.1 to 169.0	20	12	15	24	36
	30	7	9	15	22
	40	5	7	10	16
	50	4	5	8	12
169.1 to 242.0	20	13	17	27	40
	30	8	10	17	25
	40	6	7	12	17
	50	4	5	9	13
242.1 to 362.0	20	25	32	51	76
	30	16	19	31	47
	40	11	14	22	33
	50	8	10	16	25
362.1 to 420.0	20	12	15	25	37
	30	8	10	15	23

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	40	5	7	11	16
	50	4	5	8	12
420.1 to 550.0	20	23	29	47	70
	30	14	18	29	43
	40	10	13	20	30
	50	8	9	15	23
550.1 to 800.0	20	25	31	50	75
	30	15	19	31	46
	40	11	13	21	32
	50	8	10	16	24

NOTES:
* This table is for open-air, phase-to-ground electric-arc exposures. It is not for phase-to-phase arcs or enclosed arcs (arc in a box).
† The table assumes the arc length to be the sparkover distance for the maximum phase-to-ground voltage of each voltage range (see Appendix A). The table also assumes that the employee will be the minimum approach distance minus twice the arc length from the electric arc.
‡ The Department of Labor, Occupational Safety and Health Administration calculated the values in this table using the ARCPRO method listed in Table 2.
# For voltages of more than 72.6 kV, employers may use this table only when the minimum approach distance established under Section 2940.2 (a)is greater than or equal to the following values:

72.6 to 121.0 kV 1.02 m.
121.1 to 145.0 kV 1.16 m.
145.1 to 169.0 kV 1.30 m.
169.1 to 242.0 kV 1.72 m.
242.1 to 362.0 kV 2.76 m.
362.1 to 420.0 kV 2.50 m.
420.1 to 550.0 kV 3.62 m.
550.1 to 800.0 kV 4.83 m.

** The voltage range is the phase-to-phase system voltage.

B. *Selecting Protective Clothing and Other Protective Equipment*
Subsection (b) of Section 2940.11 requires employers, in certain situations, to select protective clothing and other protective equipment with an arc rating that is greater than or equal to the incident heat energy estimated under Section 2940.11(a)(2). Based on laboratory testing required by ASTM F1506-10a, the expectation is that protective clothing with an arc rating equal to the estimated incident heat energy will be capable of preventing second-degree burn injury to an

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employee exposed to that incident heat energy from an electric arc. Note that actual electric-arc exposures may be more or less severe than the estimated value because of factors such as arc movement, arc length, arcing from reclosing of the system, secondary fires or explosions, and weather conditions. Additionally, for arc rating based on the fabric's arc thermal performance value[5] (ATPV), a worker exposed to incident energy at the arc rating has a 50-percent chance of just barely receiving a second-degree burn. Therefore, it is possible (although not likely) that an employee will sustain a second-degree (or worse) burn wearing clothing conforming to Section 2940.11(b)(2) under certain circumstances. However, reasonable employer estimates and maintaining appropriate minimum approach distances for employees should limit burns to relatively small burns that just barely extend beyond the epidermis (that is, just barely a second degree burn). Consequently, protective clothing and other protective equipment meeting Section 2940.11(b)(2) will provide an appropriate degree of protection for an employee exposed to electric-arc hazards.

Subsection (b)(2) of Section 2940.11 does not require arc-rated protection for exposures of 2 cal/cm^2 or less. Untreated cotton clothing will reduce a 2-cal/cm^2 exposure below the 1.2- to 1.5-cal/cm^2 level necessary to cause burn injury, and this material should not ignite at such low heat energy levels. Although Section 2940.11(b)(2) does not require clothing to have an arc rating when exposures are 2 cal/cm^2 or less, Section 2940.11(b)(1) requires the outer layer of clothing to be flame resistant under certain conditions, even when the estimated incident heat energy is less than 2 cal/cm^2, as discussed later in this appendix.

Additionally, it is especially important to ensure that employees do not wear undergarments made from fabrics listed in Section 2940.6(j) even when the outer layer is flame resistant or arc rated. These fabrics can melt or ignite easily when an electric arc occurs. Logos and name tags made from non-flame-resistant material can adversely affect the arc rating or the flame resistant characteristics of arc-rated or flame resistant clothing. Such logos and name tags may violate Section 2940.11(b), (b)(1) , or (b)(2).

Subsection (b)(2) of Section 2940.11 requires that arc-rated protection cover the employee's entire body, with limited exceptions for the employee's hands, feet, face, and head. Subsection (b)(2)(A) of Section 2940.11 provides that arc-rated protection is not necessary for the employee's hands under the following conditions:

For any estimated incident heat energy	When the employee is wearing rubber insulating gloves with protectors.
If the estimated incident heat energy does not exceed 14 cal/cm^2	When the employee is wearing heavy-duty leather work gloves with a weight of at least 407 gm/m2 (12 oz/yd2).

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Subsection (b)(2)(B) of Section 2940.11 provides that arc-rated protection is not necessary for the employee's feet when the employee is wearing heavy-duty work shoes or boots. Finally, Section 2940.11(b)(2)(C), (b)(2)(D), and (b)(2)(E) require arc-rated head and face protection as follows:

Exposure	Minimum head and face protection		
	None *	Arc-rated faceshield with a minimum rating of 8 cal/cm^2*	Arc-rated hood or faceshield with balaclava
Single-phase, open air	2-8 cal/cm^2	9-12 cal/cm^2	13 cal/cm^2 or higher †.
Three-phase	2-4 cal/cm^2	5-8 cal/cm^2	9 cal/cm^2 or higher ‡.

* These ranges assume that employees are wearing hardhats meeting the specifications in Section 3381, as applicable.
† The arc rating shall be a minimum of 4 cal/cm^2 less than the estimated incident energy. Note that Section 2940.11(b)(2)(E) permits this type of head and face protection, with a minimum arc rating of 4 cal/cm^2 less than the estimated incident energy, at any incident energy level.
‡ Note that Section 2940.11(a)(5) permits this type of head and face protection at any incident energy level.

IV. Protection Against Ignition

Subsection (b) of Section 2940.11 prohibits clothing that could melt onto an employee's skin or that could ignite and continue to burn when exposed to flames or to the available heat energy estimated by the employer under Section 2940.11(a)(2). Meltable fabrics, such as acetate, nylon, polyester, and polypropylene, even in blends, shall be avoided. When these fibers melt, they can adhere to the skin, thereby transferring heat rapidly, exacerbating burns, and complicating treatment. These outcomes can result even if the meltable fabric is not directly next to the skin. The remainder of this section focuses on the prevention of ignition.

Section 2940.11(b)(2) generally requires protective clothing and other protective equipment with an arc rating greater than or equal to the employer's estimate of available heat energy. As explained earlier in this appendix, untreated cotton is usually acceptable for exposures of 2 cal/cm^2 or less.[6] If the exposure is greater than that, the employee generally shall wear flame-resistant clothing with a suitable arc rating in accordance with Section 2940.11(b)(1) and (b)(2). However, even if an employee is wearing a layer of flame-resistant clothing, there are circumstances under which flammable layers of clothing would be uncovered, and an electric arc

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could ignite them. For example, clothing ignition is possible if the employee is wearing flammable clothing under the flame-resistant clothing and the underlayer is uncovered because of an opening in the flame-resistant clothing. Thus, for purposes of Section 2940.11(b), it is important for the employer to consider the possibility of clothing ignition even when an employee is wearing flame-resistant clothing with a suitable arc rating.

Under Section 2940.6(j), employees may not wear flammable clothing in conjunction with flame-resistant clothing if the flammable clothing poses an ignition hazard.[7] Although outer flame-resistant layers may not have openings that expose flammable inner layers, when an outer flame-resistant layer would be unable to resist breakopen,[8] the next (inner) layer shall be flame-resistant if it could ignite.

Non-flame-resistant clothing can ignite even when the heat energy from an electric arc is insufficient to ignite the clothing. For example, nearby flames can ignite an employee's clothing; and, even in the absence of flames, electric arcs pose ignition hazards beyond the hazard of ignition from incident energy under certain conditions. In addition to requiring flame-resistant clothing when the estimated incident energy exceeds 2.0 cal/cm^2, Section 2940.11(b)(1) requires flame-resistant clothing when: The employee is exposed to contact with energized circuit parts operating at more than 600 volts [Section 2940.11(b)(1)(A)], an electric arc could ignite flammable material in the work area that, in turn, could ignite the employee's clothing [Section 2940.11(b)(1)(B)], and molten metal or electric arcs from faulted conductors in the work area could ignite the employee's clothing [Section 2940.11(b)(1)(C)]. For example, grounding conductors can become a source of heat energy if they cannot carry fault current without failure. The employer shall consider these possible sources of electric arcs[9] in determining whether the employee's clothing could ignite under Section 2940.11(b)(1)(C).

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[1] Flame-resistant clothing includes clothing that is inherently flame resistant and clothing chemically treated with a flame retardant. (See ASTM F1506-10a, Standard Performance Specification for Flame Resistant Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards, and ASTM F1891-12 Standard Specification for Arc and Flame Resistant Rainwear.)
[2] The Department of Labor, Occupational Safety and Health Administration used metric values to calculate the clearing times in Table 6 and Table 7. An employer may use English units to calculate clearing times instead even though the results will differ slightly.
[3] The Department of Labor, Occupational Safety and Health Administration based this assumption, which is more conservative than the arc length specified in Table 5, on Table 410-2 of the 2012 NESC.
[4] The dielectric strength of air is about 10 kilovolts for every 25.4 millimeters (1 inch). Thus, the employer can estimate the arc length in millimeters to be the phase-to-ground voltage in kilovolts multiplied by 2.54 (or voltage (in kilovolts) × 2.54).

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[5] ASTM F1506-10a defines "arc thermal performance value" as "the incident energy on a material or a multilayer system of materials that results in a 50% probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn injury based on the Stoll [footnote] curve, cal/cm^2." The footnote to this definition reads: "Derived from: Stoll, A. M., and Chianta, M. A., 'Method and Rating System for Evaluations of Thermal Protection,' Aerospace Medicine, Vol 40, 1969, pp. 1232-1238 and Stoll, A. M., and Chianta, M. A., 'Heat Transfer through Fabrics as Related to Thermal Injury,' Transactions-New York Academy of Sciences, Vol 33(7), Nov. 1971, pp. 649-670."
[6] See Section 2940.11(a)(4)(A), (a)(4)(B), and (a)(4)(C) for conditions under which employees shall wear flame-resistant clothing as the outer layer of clothing even when the incident heat energy does not exceed 2 cal/cm^2.
[7] Subsection (a)(3) of Section 2940.11 prohibits clothing that could ignite and continue to burn when exposed to the heat energy estimated under subsection (a)(2) of that section.
[8] Breakopen occurs when a hole, tear, or crack develops in the exposed fabric such that the fabric no longer effectively blocks incident heat energy.
[9] Static wires and pole grounds are examples of grounding conductors that might not be capable of carrying fault current without failure. Grounds that can carry the maximum available fault current are not a concern, and employers need not consider such grounds a possible electric arc source.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Add new Appendix E to Article 36 to read:

Appendix E

PROTECTION FROM HAZARDOUS DIFFERENCES IN ELECTRIC POTENTIAL

I. Introduction

Current passing through an impedance impresses voltage across that impedance. Even conductors have some, albeit low, value of impedance. Therefore, if a "grounded"[1] object, such as a crane or deenergized and grounded power line, results in a ground fault on a power line, voltage is impressed on that grounded object. The voltage impressed on the grounded object depends largely on the voltage on the line, on the impedance of the faulted conductor, and on the impedance to "true," or "absolute," ground represented by the object. If the impedance of the object causing the fault is relatively large, the voltage impressed on the object is essentially the phase-to-ground system voltage. However, even faults to grounded power lines or to well grounded transmission towers or substation structures (which have relatively low values of impedance to ground) can result in hazardous voltages.[2] In all cases, the degree of the hazard depends on the magnitude of the current through the employee and the time of exposure. This appendix discusses methods of protecting workers against the possibility that grounded objects, such as cranes and other mechanical equipment, will contact energized power lines and that deenergized and grounded power lines will become accidentally energized.

II. Voltage-Gradient Distribution

A. *Voltage-gradient distribution curve.* Absolute, or true, ground serves as a reference and always has a voltage of 0 volts above ground potential. Because there is an impedance between a grounding electrode and absolute ground, there will be a voltage difference between the grounding electrode and absolute ground under ground-fault conditions. Voltage dissipates from the grounding electrode (or from the grounding point) and creates a ground potential gradient. The voltage decreases rapidly with increasing distance from the grounding electrode. A voltage drop associated with this dissipation of voltage is a ground potential. Figure 1 is a typical voltage-gradient distribution curve (assuming a uniform soil texture).

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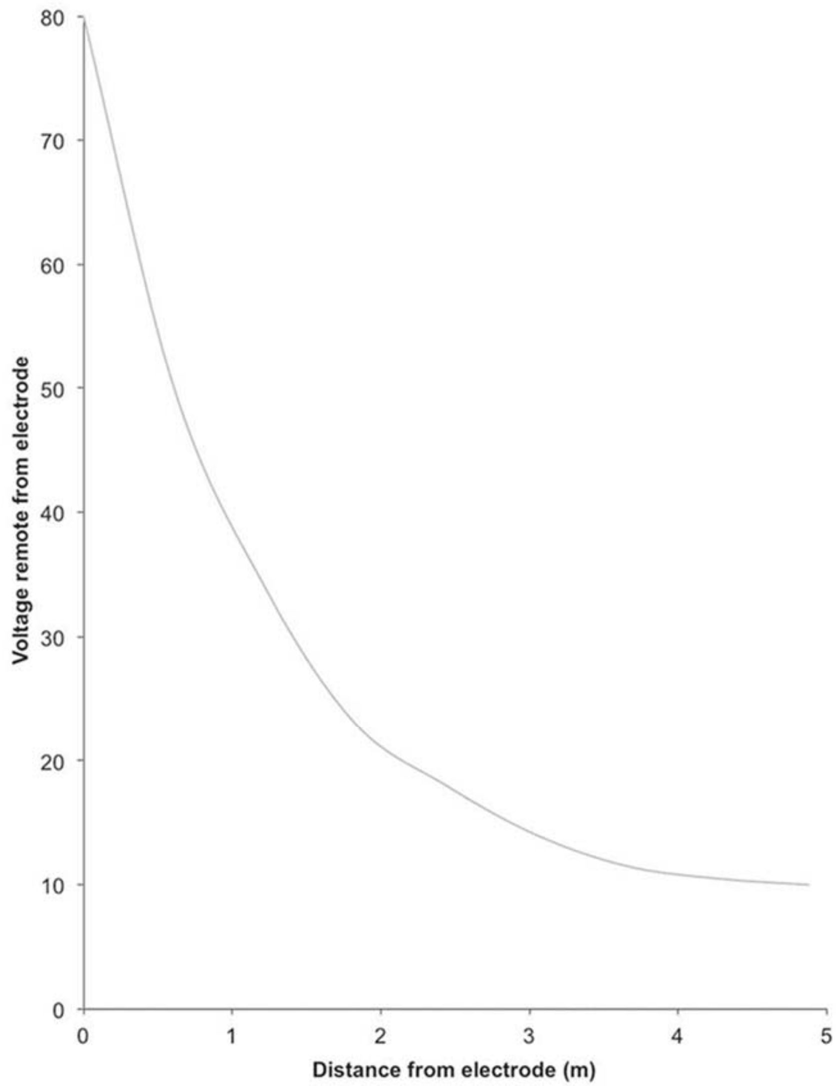

Figure 1 - Typical Voltage - Gradient Distribution Curve

B. *Step and touch potentials.* Figure 1 also shows that workers are at risk from step and touch potentials. Step potential is the voltage between the feet of a person standing near an energized grounded object (the electrode). In Figure 1, the step potential is equal to the difference in voltage between two points at different distances from the electrode (where the points represent the location of each foot in relation to the electrode). A person could be at risk of injury during a fault simply by standing near the object.

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Touch potential is the voltage between the energized grounded object (again, the electrode) and the feet of a person in contact with the object. In Figure 1, the touch potential is equal to the difference in voltage between the electrode (which is at a distance of 0 meters) and a point some distance away from the electrode (where the point represents the location of the feet of the person in contact with the object). The touch potential could be nearly the full voltage across the grounded object if that object is grounded at a point remote from the place where the person is in contact with it. For example, a crane grounded to the system neutral and that contacts an energized line would expose any person in contact with the crane or its uninsulated load line to a touch potential nearly equal to the full fault voltage.

Figure 2 illustrates step and touch potentials.

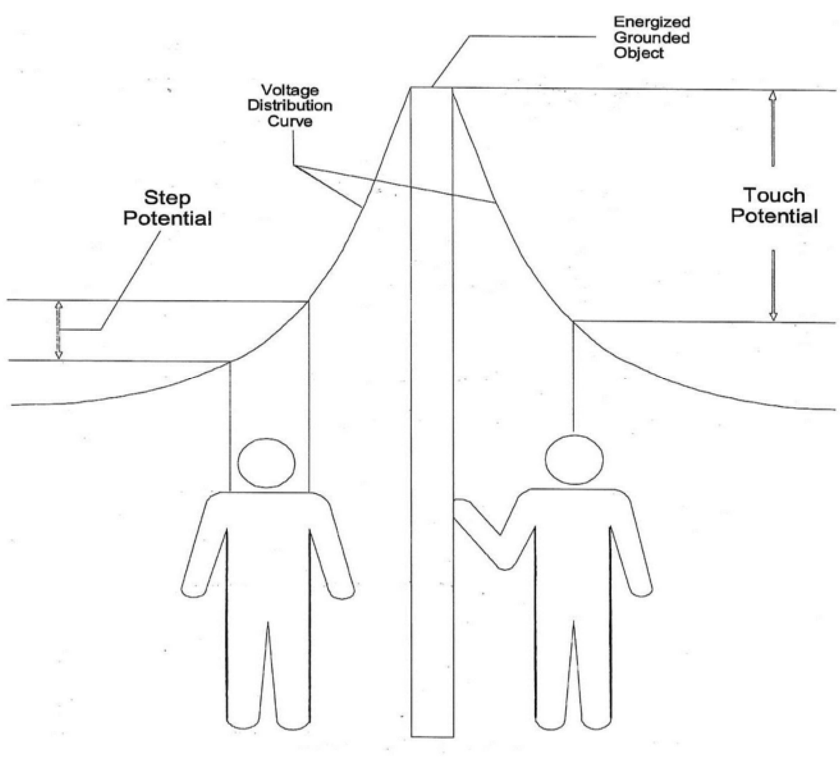

Figure 2—Step and Touch Potentials

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III. Protecting Workers From Hazardous Differences in Electrical Potential

A. *Definitions.* The following definitions apply to section III of this appendix:
Bond. The electrical interconnection of conductive parts designed to maintain a common electric potential.
Bonding cable (bonding jumper). A cable connected to two conductive parts to bond the parts together.
Cluster bar. A terminal temporarily attached to a structure that provides a means for the attachment and bonding of grounding and bonding cables to the structure.
Ground. A conducting connection between an electric circuit or equipment and the earth, or to some conducting body that serves in place of the earth.
Grounding cable (grounding jumper). A cable connected between a deenergized part and ground. Note that grounding cables carry fault current and bonding cables generally do not. A cable that bonds two conductive parts but carries substantial fault current (for example, a jumper connected between one phase and a grounded phase) is a grounding cable.
Ground mat (grounding grid). A temporarily or permanently installed metallic mat or grating that establishes an equipotential surface and provides connection points for attaching grounds.
B. *Analyzing the hazard.* The employer can use an engineering analysis of the power system under fault conditions to determine whether hazardous step and touch voltages will develop. The analysis should determine the voltage on all conductive objects in the work area and the amount of time the voltage will be present. Based on the this analysis, the employer can select appropriate measures and protective equipment, including the measures and protective equipment outlined in Section III of this appendix, to protect each employee from hazardous differences in electric potential. For example, from the analysis, the employer will know the voltage remaining on conductive objects after employees install bonding and grounding equipment and will be able to select insulating equipment with an appropriate rating, as described in Section III.C.2 of this appendix.
C. *Protecting workers on the ground.* The employer may use several methods, including equipotential zones, insulating equipment, and restricted work areas, to protect employees on the ground from hazardous differences in electrical potential.
1. An equipotential zone will protect workers within it from hazardous step and touch potentials. (See Figure 3.) Equipotential zones will not, however, protect employees located either wholly or partially outside the protected area. The employer can establish an equipotential zone for workers on the ground, with respect to a grounded object, through the use of a metal mat connected to the grounded object. The employer can use a grounding grid to equalize the voltage within the grid or bond conductive objects in the immediate work area to minimize the potential between the objects and between each object and ground. (Bonding an object outside the work area can increase the touch potential to that object, however.) Section III.D of this appendix discusses equipotential zones for employees working on deenergized and grounded power lines.

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2. Insulating equipment, such as rubber gloves, can protect employees handling grounded equipment and conductors from hazardous touch potentials. The insulating equipment shall be rated for the highest voltage that can be impressed on the grounded objects under fault conditions (rather than for the full system voltage).

3. Restricting employees from areas where hazardous step or touch potentials could arise can protect employees not directly involved in performing the operation. The employer shall ensure that employees on the ground in the vicinity of transmission structures are at a distance where step voltages would be insufficient to cause injury. Employees shall not handle grounded conductors or equipment likely to become energized to hazardous voltages unless the employees are within an equipotential zone or protected by insulating equipment.

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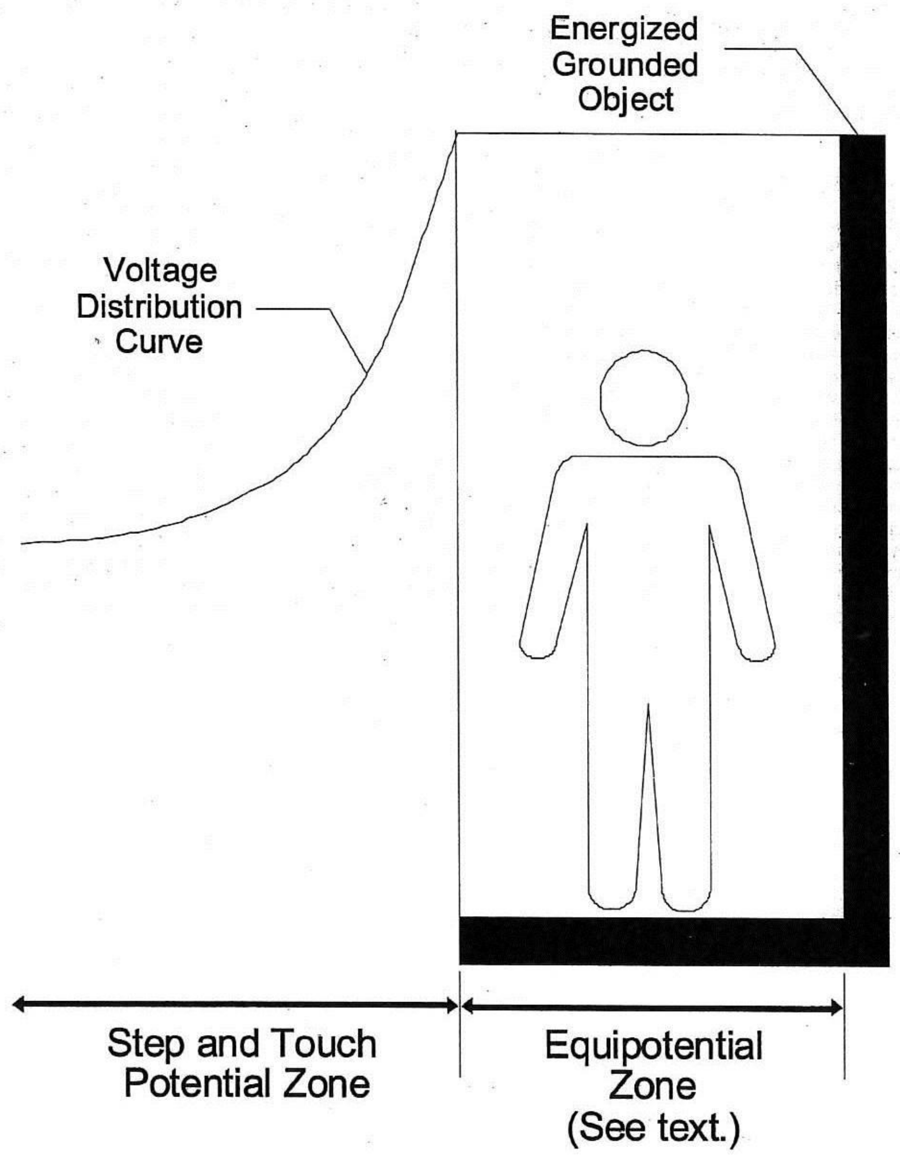

Figure 3—Protection from Ground-Potential Gradients

D. *Protecting employees working on deenergized and grounded power lines.* This Section III.D of Appendix E establishes guidelines to help employers comply with requirements in Section 2940.15 for using protective grounding to protect employees working on deenergized power lines. Section 2940.15 applies to grounding of transmission and distribution lines and equipment for the purpose of protecting workers. Subsection (e) of Section 2940.15 requires temporary

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protective grounds to be placed at such locations and arranged in such a manner that the employer can demonstrate will prevent exposure of each employee to hazardous differences in electric potential.[3] Sections III.D.1 and III.D.2 of this appendix provide guidelines that employers can use in making the demonstration required by Section 2940.15(e). Section III.D.1 of this appendix provides guidelines on how the employer can determine whether particular grounding practices expose employees to hazardous differences in electric potential. Section III.D.2 of this appendix describes grounding methods that the employer can use in lieu of an engineering analysis to make the demonstration required by Section 2940.15(e). The Division of Occupational Safety and Health will consider employers that comply with the criteria in this appendix as meeting Section 2940.15(e).

Finally, Section III.D.3 of this appendix discusses other safety considerations that will help the employer comply with other requirements in Section 2940.15. Following these guidelines will protect workers from hazards that can occur when a deenergized and grounded line becomes energized.

1. *Determining safe body current limits.* This Section III.D.1 of Appendix E provides guidelines on how an employer can determine whether any differences in electric potential to which workers could be exposed are hazardous as part of the demonstration required by Section 2940.14(e).

Institute of Electrical and Electronic Engineers (IEEE) Standard 1048-2003, *IEEE Guide for Protective Grounding of Power Lines*, provides the following equation for determining the threshold of ventricular fibrillation when the duration of the electric shock is limited:

$$I = \frac{116}{\sqrt{t}},$$

where I is the current through the worker's body, and t is the duration of the current in seconds. This equation represents the ventricular fibrillation threshold for 95.5 percent of the adult population with a mass of 50 kilograms (110 pounds) or more. The equation is valid for current durations between 0.0083 to 3.0 seconds.

To use this equation to set safe voltage limits in an equipotential zone around the worker, the employer will need to assume a value for the resistance of the worker's body. IEEE Std 1048-2003 states that "total body resistance is usually taken as 1000 Ω for determining . . . body current limits." However, employers should be aware that the impedance of a worker's body can be substantially less than that value. For instance, IEEE Std 1048-2003 reports a minimum hand-to-hand resistance of 610 ohms and an internal body resistance of 500 ohms. The internal resistance of the body better represents the minimum resistance of a worker's body when the skin resistance drops near zero, which occurs, for example, when there are breaks in the worker's skin, for instance, from cuts or from blisters formed as a result of the current from an electric shock, or when the worker is wet at the points of contact.

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Employers may use the IEEE Std 1048-2003 equation to determine safe body current limits only if the employer protects workers from hazards associated with involuntary muscle reactions from electric shock (for example, the hazard to a worker from falling as a result of an electric shock). Moreover, the equation applies only when the duration of the electric shock is limited. If the precautions the employer takes, including those required by applicable standards, do not adequately protect employees from hazards associated with involuntary reactions from electric shock, a hazard exists if the induced voltage is sufficient to pass a current of 1 mill amperes through a 500-ohm resistor. (The 500-ohm resistor represents the resistance of an employee. The 1-milliampere current is the threshold of perception.) Finally, if the employer protects employees from injury due to involuntary reactions from electric shock, but the duration of the electric shock is unlimited (that is, when the fault current at the work location will be insufficient to trip the devices protecting the circuit), a hazard exists if the resultant current would be more than 6 milliamperes (the recognized let-go threshold for workers [4]).

2. *Acceptable methods of grounding for employers that do not perform an engineering determination.* The grounding methods presented in this section of this appendix ensure that differences in electric potential are as low as possible and, therefore, meet Section 2940.15(e) without an engineering determination of the potential differences. These methods follow two principles: (i) The grounding method shall ensure that the circuit opens in the fastest available clearing time, and (ii) the grounding method shall ensure that the potential differences between conductive objects in the employee's work area are as low as possible.

Subsection (e) of Section 2940.15 does not require grounding methods to meet the criteria embodied in these principles. Instead, the subsection requires that protective grounds be "placed at such locations and arranged in such a manner that the employer can demonstrate will prevent exposure of each employee to hazardous differences in electric potential." However, when the employer's grounding practices do not follow these two principles, the employer will need to perform an engineering analysis to make the demonstration required by Section 2940.15(e).

i. *Ensuring that the circuit opens in the fastest available clearing time.* Generally, the higher the fault current, the shorter the clearing times for the same type of fault. Therefore, to ensure the fastest available clearing time, the grounding method shall maximize the fault current with a low impedance connection to ground. The employer accomplishes this objective by grounding the circuit conductors to the best ground available at the worksite. Thus, the employer shall ground to a grounded system neutral conductor, if one is present. A grounded system neutral has a direct connection to the system ground at the source, resulting in an extremely low impedance to ground. In a substation, the employer may instead ground to the substation grid, which also has an extremely low impedance to the system ground and, typically, is connected to a grounded system neutral when one is present. Remote system grounds, such as pole and tower grounds, have a higher impedance to the system ground than grounded system neutrals and substation grounding grids; however, the employer may use a remote ground when lower impedance grounds are not available. In the absence of a grounded system neutral, substation grid, and remote ground, the employer may use a temporary driven ground at the worksite.

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In addition, if employees are working on a three-phase system, the grounding method shall short circuit all three phases. Short circuiting all phases will ensure faster clearing and lower the current through the grounding cable connecting the deenergized line to ground, thereby lowering the voltage across that cable. The short circuit need not be at the worksite; however, the employer shall treat any conductor that is not grounded at the worksite as energized because the ungrounded conductors will be energized at fault voltage during a fault.

ii. *Ensuring that the potential differences between conductive objects in the employee's work area are as low as possible.* To achieve as low a voltage as possible across any two conductive objects in the work area, the employer shall bond all conductive objects in the work area. This section of this appendix discusses how to create a zone that minimizes differences in electric potential between conductive objects in the work area.

The employer shall use bonding cables to bond conductive objects, except for metallic objects bonded through metal-to-metal contact. The employer shall ensure that metal-to-metal contacts are tight and free of contamination, such as oxidation, that can increase the impedance across the connection. For example, a bolted connection between metal lattice tower members is acceptable if the connection is tight and free of corrosion and other contamination. Figure 4 shows how to create an equipotential zone for metal lattice towers.

Wood poles are conductive objects. The poles can absorb moisture and conduct electricity, particularly at distribution and transmission voltages. Consequently, the employer shall either: (1) Provide a conductive platform, bonded to a grounding cable, on which the worker stands or (2) use cluster bars to bond wood poles to the grounding cable. The employer shall ensure that employees install the cluster bar below, and close to, the worker's feet. The inner portion of the wood pole is more conductive than the outer shell, so it is important that the cluster bar be in conductive contact with a metal spike or nail that penetrates the wood to a depth greater than or equal to the depth the worker's climbing gaffs will penetrate the wood. For example, the employer could mount the cluster bar on a bare pole ground wire fastened to the pole with nails or staples that penetrate to the required depth. Alternatively, the employer may temporarily nail a conductive strap to the pole and connect the strap to the cluster bar. Figure 5 shows how to create an equipotential zone for wood poles.

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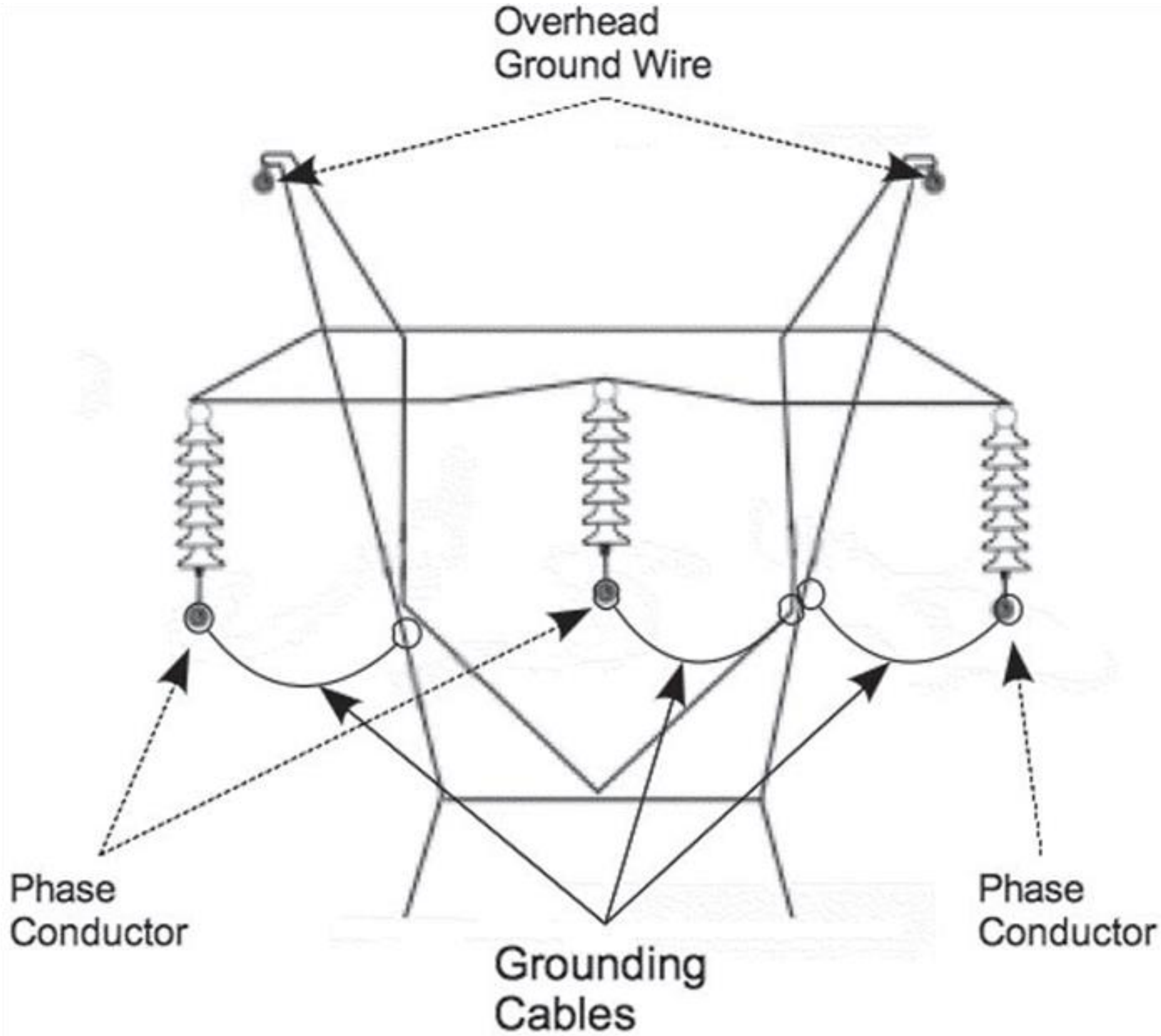

Figure 4 - Equipotential Zone for Metal Lattice Tower

NOTES:
1. Employers shall ground overhead ground wires that are within reach of the employee.
2. The grounding cable must be as short as practicable; therefore, the attachment points between the grounding cable and the tower may be different from the shown in the figure.

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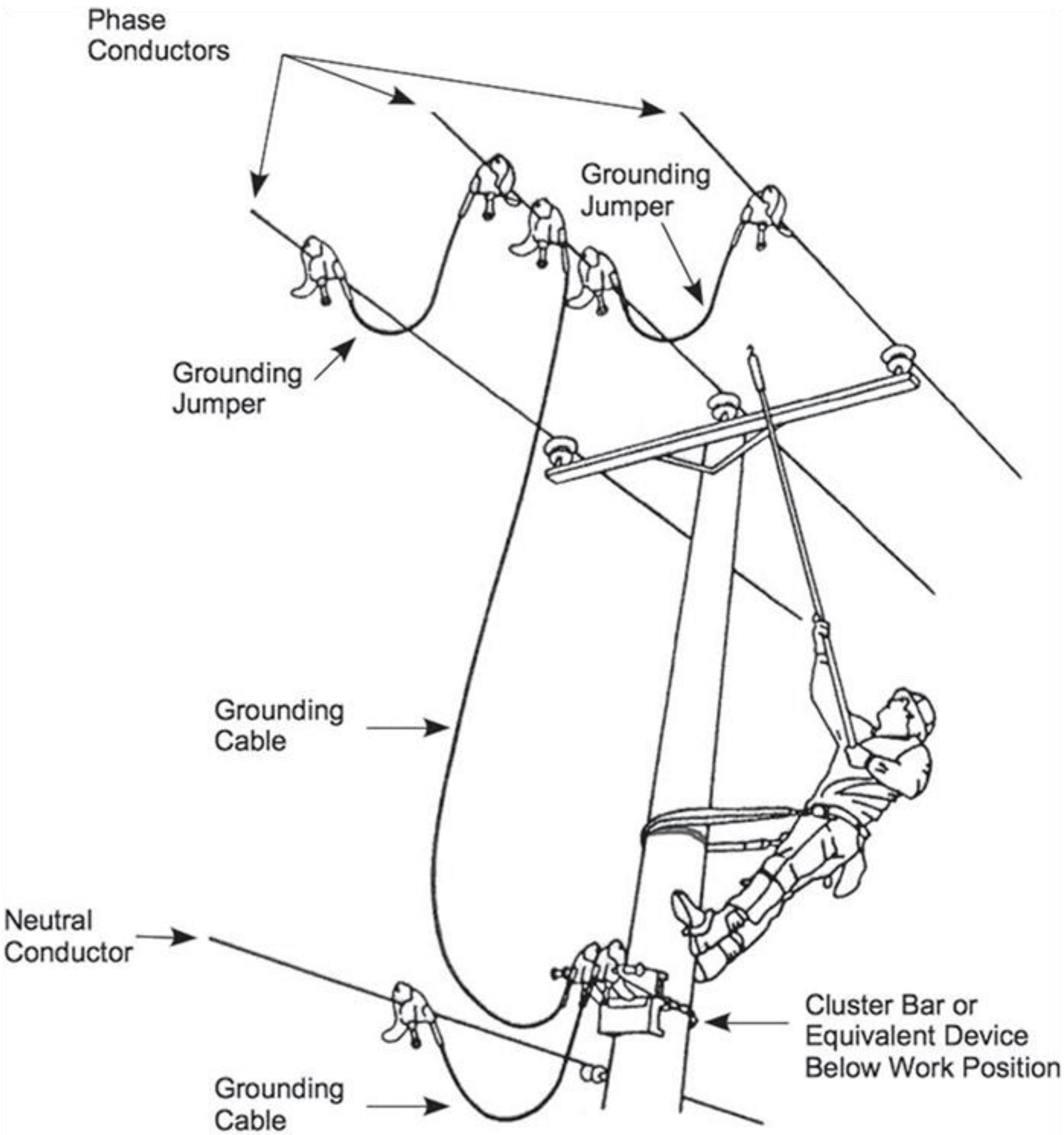

Figure 5 - Equipotential Grounding for Wood Poles

Figure reprinted with permission from Hubbel Power Systems, Inc. (Hubbell).

OSHA revised the figure from Hubbell's original.

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For underground systems, employers commonly install grounds at the points of disconnection of the underground cables. These grounding points are typically remote from the manhole or underground vault where employees will be working on the cable. Workers in contact with a cable grounded at a remote location can experience hazardous potential differences if the cable becomes energized or if a fault occurs on a different, but nearby, energized cable. The fault current causes potential gradients in the earth, and a potential difference will exist between the earth where the worker is standing and the earth where the cable is grounded. Consequently, to create an equipotential zone for the worker, the employer shall provide a means of connecting the deenergized cable to ground at the worksite by having the worker stand on a conductive mat bonded to the deenergized cable. If the cable is cut, the employer shall install a bond across the opening in the cable or install one bond on each side of the opening to ensure that the separate cable ends are at the same potential. The employer shall protect the worker from any hazardous differences in potential any time there is no bond between the mat and the cable (for example, before the worker installs the bonds).

3. Other safety-related considerations. To ensure that the grounding system is safe and effective, the employer should also consider the following factors: [5]

i. *Maintenance of grounding equipment.* It is essential that the employer properly maintain grounding equipment. Corrosion in the connections between grounding cables and clamps and on the clamp surface can increase the resistance of the cable, thereby increasing potential differences. In addition, the surface to which a clamp attaches, such as a conductor or tower member, shall be clean and free of corrosion and oxidation to ensure a low-resistance connection. Cables shall be free of damage that could reduce their current-carrying capacity so that they can carry the full fault current without failure. Each clamp shall have a tight connection to the cable to ensure a low resistance and to ensure that the clamp does not separate from the cable during a fault.

ii. *Grounding cable length and movement.* The electromagnetic forces on grounding cables during a fault increase with increasing cable length. These forces can cause the cable to move violently during a fault and can be high enough to damage the cable or clamps and cause the cable to fail. In addition, flying cables can injure workers. Consequently, cable lengths should be as short as possible, and grounding cables that might carry high fault current should be in positions where the cables will not injure workers during a fault.

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[1] This appendix generally uses the term "grounded" only with respect to grounding that the employer intentionally installs, for example, the grounding an employer installs on a deenergized conductor. However, in this case, the term "grounded" means connected to earth, regardless of whether or not that connection is intentional.

[2] Thus, grounding systems for transmission towers and substation structures should be designed to minimize the step and touch potentials involved.

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[3] The protective grounding required by Section 2940.15 limits to safe values the potential differences between accessible objects in each employee's work environment. Ideally, a protective grounding system would create a true equipotential zone in which every point is at the same electric potential. In practice, current passing through the grounding and bonding elements creates potential differences. If these potential differences are hazardous, the employer may not treat the zone as an equipotential zone.

[4] Electric current passing through the body has varying effects depending on the amount of the current. At the let-go threshold, the current overrides a person's control over his or her muscles. At that level, an employee grasping an object will not be able to let go of the object. The let-go threshold varies from person to person; however, the recognized value for workers is 6 milliamperes.

[5] This appendix only discusses factors that relate to ensuring an equipotential zone for employees. The employer shall consider other factors in selecting a grounding system that is capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault, as required by Section 2940.14(f)(2). IEEE Std 1048-2003 contains guidelines for selecting and installing grounding equipment that will meet Section 2940.14(f)(2).

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Safety Orders
Article 37. Provisions for Preventing Accidents Due to Proximity to Overhead Lines

Amend Section 2946 to read:

§2946. Provisions for Preventing Accidents Due to Proximity to Overhead Lines.

*****

(b) Clearances or Safeguards Required. Except where overhead electrical distribution and transmission lines have been de-energized and visibly grounded, the following provisions shall be met:

*****

(4) Storage. The storage of tools, machinery, equipment, supplies, materials, or apparatus under, by, or near energized overhead high-voltage lines is hereby expressly prohibited if at any time during such handling or other manipulation it is possible to bring such tools, machinery, equipment, supplies, materials, or apparatus, or any part thereof, closer than the minimum clearances from such lines as set forth in ~~Table 1~~ <u>Table 2</u>.

(c) The specified clearance shall not be reduced by movement due to any strains impressed (by attachments or otherwise) upon the structures supporting the overhead high-voltage line or upon any equipment, fixtures, or attachments thereon.

(d) Any overhead conductor shall be considered to be energized unless and until the person owning or operating such line verifies that the line is not energized, and the line is visibly grounded at the work site.

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TABLE 2

Material Storage and Boom-type lifting or hoisting equipment clearances required from energized overhead high-voltage lines.

Nominal voltage (Phase to Phase)	Minimum Required Clearance (Feet)
600....... 50,000	10
over 50,000...... 75,000	11
over 75,000..... 125,000	13
over 125,000.... 175,000	15
over 175,000.... 250,000	17
over 250,000.... 370,000	21
over 370,000.... 550,000	27
over 550,000... 1,000,000	42

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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Electrical Safety Orders
Group 2. High-Voltage Electrical Safety Orders
Article 38. Line Clearance Tree Trimming Operations

Amend Section 2951 to read:

§2951. Line Clearance (Tree Trimming) Operations.

(a) Prior to commencing line clearance tree trimming operations, the employer shall ensure that an inspection of the work locations is made in order to identify potential hazards and a tail gate briefing is conducted to discuss the work procedures to be followed. A determination shall be made of the nominal voltage of electric power lines posing a hazard to employees. However, a determination of the maximum nominal voltage to which an employee will be exposed may be made instead, if all lines are considered as energized at this maximum voltage.

(b) Only qualified line clearance tree trimmers, or trainees under the direct supervision and instruction of qualified line clearance tree trimmers, shall be permitted to perform line clearance tree trimming operations as described in Section 2950. Under no circumstances shall the minimum approach distances specified in Section 2940.2~~(b) Table 2940.2~~, be violated.

(c) The employee in charge of each independent crew shall coordinate the de-energizing and re-energizing of high-voltage lines with the operator of the high-voltage line(s).
Adjacent

(d) During all tree trimming operations performed in accordance with the requirements of subsection (b) above, there shall be another qualified line clearance tree trimmer or trainee within normal (that is, unassisted) voice communication at each work location to render immediate assistance.

*****

(g) Ladders, platforms and aerial devices shall not be brought closer to an energized part than the distances listed in Section 2940.2.

(h) Sprayers and Related Equipment.

> (1) Walking and working surfaces of sprayers and related equipment shall be covered with slip-resistant material. If slipping hazards cannot be eliminated, slip-resistant footwear or handrails and stair rails meeting the requirements of Section 3214 of the General Industry Safety Orders may be used instead of slip-resistant material.

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(2) Equipment on which employees stand to spray while the vehicle is in motion shall be equipped with guardrails around the working area. The guardrail shall be constructed in accordance with the requirements of Article 2, Section 3209 of the General Industry Safety Orders.

(i) Rope.

(1) When stored, rope shall be coiled and piled, or shall be suspended, so that air can circulate through the coils.

(2) A rope that is wet, that is contaminated to the extent that its insulating capacity is impaired, or that is otherwise not considered to be insulated for the voltage involved shall not be used near exposed energized lines.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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General Industry Safety Orders
Article 7. Miscellaneous Safe Practices

Amend Section 3314 to read:

§3314. The Control of Hazardous Energy for the Cleaning, Repairing, Servicing, Setting-Up, and Adjusting Operations of Prime Movers, Machinery and Equipment, Including Lockout/Tagout.

(a) Application.

(1) This Section applies to the cleaning, repairing, servicing, setting-up and adjusting of machines and equipment in which the unexpected energization or start-up of the machines or equipment, or release of stored energy could cause injury to employees.

(2) For the purposes of this Section, cleaning, repairing, servicing and adjusting activities shall include unjamming prime movers, machinery and equipment.

(3) Requirements for working on energized electrical systems are prescribed in Sections 2320.1 through 2320.9 or 2940 through 2945.

(4) Energy control procedures for the control of energy sources in installations for the purpose of electric power generation, including related equipment for communication or metering shall be in accordance with Section 2940.13.

NOTE to subsection (a)(4): Compliance with Section 2940.13 is considered equivalent to complying with Section 3314.

(5) Deenergizing procedures of transmission lines and equipment for the purpose of protecting employees shall be in accordance with Section 2940.14.

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NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

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General Industry Safety Orders
Article 10. Personal Safety Devices and Safeguards

Amend Section 3389 to read:

§3389. Life Rings and Personal Flotation Devices.

(a) At least one U.S. Coast Guard approved 30-inch life ring with not less than 90 feet of 600 pound capacity line attached shall be kept in a conveniently accessible place where employees work exposes them to the hazard of drowning or each employee so exposed shall wear a U.S. Coast Guard approved personal flotation device.

EXCEPTION: Flume Patrol. Flumes provided with caps as described in Section 3207.

(b) Any personal flotation device shall be approved by the United States Coast Guard as a Type I PFD, Type II PFD, Type III PFD, or their equivalent, pursuant to 46 CFR 160 (Coast Guard Lifesaving Equipment Specifications) and 33 CFR 175.23 (Coast Guard table of devices equivalent to personal flotation devices.)

(c) Personal flotation devices shall be maintained in good condition. The employer shall inspect each personal flotation device frequently enough to ensure that it does not have rot, mildew, water saturation, or any other condition that could render the device unsuitable for use. They shall be removed from service when damaged so as to affect their buoyant properties or capability of being fastened.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

TITLE 8, DIVISION 1, CHAPTER 4

General Industry Safety Orders
Article 12. Treework, Maintenance, or Removal

Amend Section 3422 to read:

§3422. Ropes and Tree Worker Climbing Equipment.

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(i) Rope and climbing equipment shall be stored and transported in a manner that prevents damage by contact with sharp tools and cutting edges, gas, oil and chemicals.

(1) When stored, rope shall be coiled and piled, or shall be suspended, so that air can circulate through the coils.

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NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

TITLE 8, DIVISION 1, CHAPTER 4

General Industry Safety Orders
Article 12. Tree Work, Maintenance or Removal

Amend Section 3425 to read:

§3425. Portable Power Hand Tools.

(a) Power Saws.

(1) Power saws shall be operated and maintained in accordance with the manufacturer's instructions.

~~(2) Power saws weighing more than fifteen pounds (service weight) that are used in trees shall be supported by a separate line or tool lanyard, except when working from an aerial lift device or during topping or removing operations where no supporting limb is available.~~
[Existing subsection (a)(2) is relocated to new subsection (a)(6)]

<u>(2) A power saw shall be started on the ground or where it is otherwise firmly supported. Drop starting of saws over 6.8 kilograms (15 pounds), other than chain saws, is permitted outside of the bucket of an aerial lift only if the area below the lift is clear of personnel.</u>

(3) All power saws shall be equipped with a constant pressure control that will return the saw to idling speed when released.

<u>(4) A power saw engine shall not be started and operated unless all employees other than the operator are clear of the saw.</u>

<u>(5) A power saw shall not be running when the saw is being carried up into a tree by an employee.</u>

<u>(6) Power saws weighing more than fifteen pounds (service weight) that are used in trees shall be supported by a separate line or tool lanyard, except when working from an aerial-lift device or during topping or removing operations where no supporting limb is available.</u>
[New subsection (a)(6) is transferred from existing subsection (a)(2)]

~~(4)~~<u>(7)</u> Power saws shall be <u>equipped with a clutch and be</u> so adjusted that the chain drive will not engage at idling speed.

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~~(5)~~(8) Power saw engines shall be stopped when carried for a distance greater than 100 feet, or in hazardous conditions such as slippery surfaces or heavy underbrush. Chain brakes shall be engaged or the saw engine stopped when the saw is carried a distance greater than 10 feet.

~~(6)~~(9) The saw shall be stopped for all cleaning, refueling, adjustments, and repairs to the saw or engine where practicable, except where manufacturers' instructions require otherwise.

~~(7)~~(10) Tree workers shall use a second point of attachment such as a work-positioning lanyard or double-crotched rope when operating a chain saw in a tree, unless the employer demonstrates that a greater hazard is posed by using a second point of attachment while operating chain saws in that particular situation.

~~(8)~~(11) While a powered pole saw or brush saw is running, no one shall be permitted within 10 feet of the cutting head, except the operator.

~~(9)~~(12) Powered saws shall be equipped with a quick shutoff switch readily accessible to the operator.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

TITLE 8, DIVISION 1, CHAPTER 4

General Industry Safety Orders
Article 12. Tree Work, Maintenance or Removal

Add new Section 3428 to read:

§3428. Stump Cutters.

(a) Stump cutters shall be equipped with enclosures or guards to protect employees.

(b) Each employee in the immediate area of stump grinding operations (including the stump cutter operator) shall wear personal protective equipment as required by Article 10 of the General Industry Safety Orders.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

TITLE 8, DIVISION 1, CHAPTER 4

General Industry Safety Orders
Article 108. Confined Spaces

Amend Section 5156 to read:

§5156. Scope, Application and Definitions.

(a) Scope. This Article prescribes minimum standards for preventing employee exposure to confined space hazards, as defined by Section 5156(b), within such spaces as silos, tanks, vats, vessels, boilers, compartments, ducts, sewers, pipelines, vaults, bins, tubs, and pits.

NOTE: This Article does not apply to underwater operations conducted in diving bells or other underwater devices or to supervised hyperbaric facilities.

(b) Application and ~~d~~Definitions.

(1) For operations and industries not identified in subsection (b)(2), the confined space definition along with other definitions and requirements of ~~s~~Section 5157, Permit-Required Confined Spaces shall apply.

(2) The confined space definition along with other definitions and requirements of ~~s~~Section 5158, Other Confined Space Operations shall apply to:

(A) Construction operations regulated by ~~s~~Section 1502;

(B) Agriculture operations (including cotton gins) defined by ~~s~~Section 3437;

(C) Marine terminal operations defined in ~~s~~Section 3460;

(D) Telecommunication manholes and unvented vaults regulated by ~~s~~Section 8616;

(E) Grain handling facilities regulated by ~~s~~Section 5178~~.~~; or

(F) Natural gas utility operation within distribution and transmission facility vaults defined in Title 49 Code of Federal Regulations Parts 191, 192 and 193~~; or~~.

~~(G) Electric utility operations within underground vaults. See section 2700 for a definition of vault.~~

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NOTE: Electric utility operations within underground vaults. See Section 2700 for a definition of vault and Section 2943(b) for manholes and Section 2943.1 for enclosed spaces.

NOTE: Shipyard operations are regulated by sSection 8355.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

TITLE 8, DIVISION 1, CHAPTER 4

Telecommunications Safety Orders
Article 1. Telecommunications

Amend Section 8617 to read:

§8617. Eye Protection.

(a) Microwave. Employers shall require that employees do not look into an open waveguide or antenna which is connected to an energized source of microwave radiation.

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NOTE: ~~Authority and reference cited: Section 142.3, Labor Code.~~
Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.