

**State of Arkansas
Department of Labor
Safety Code**

**SAFETY CODE NO. 11
Electrical Transmission/Distribution Facilities**

**Promulgated by
The Arkansas Department of Labor
Little Rock, Arkansas**

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These rules and regulations are promulgated by the Director of the Arkansas Department of Labor pursuant to the authority granted by Arkansas Code 11-2-110.

(a) PURPOSE AND SCOPE.

(1) Senate Resolution 35 of the 79th General Assembly established an Industry and Labor Commission to make recommendations to the Arkansas Department of Labor concerning Safety Code No. 11, promulgated February 25, 1963. This commission submitted its report and recommendations to the Director of Labor on July 7, 1993. The Director of Labor, giving due deference to the recommendations of the commission, hereby promulgates these regulations.

(2) The purpose of these regulations is to establish minimum safety standards for employees performing operation or maintenance work or construction work on electric power generation, transmission or distribution installations and facilities.

(3) These regulations apply to all employees in the State of Arkansas performing operation or maintenance work or construction work on electric power generation, transmission or distribution installations and facilities.

(b) REPEALER.

Safety Code No. 11 promulgated February 25, 1963, is hereby repealed and replaced with these regulations.

(c) MINIMUM STANDARDS.

(1) The following are hereby adopted by reference and incorporated herein:

(A) OSHA Safety and Health Regulations for Construction, Power Transmission and Distribution, 29 C.F.R. §§ 1926.950-.960 (1992);

(B) Proposed Amendment to OSHA Safety and Health Regulations for General Industry, 54 Fed. Reg. 5007-5009 (1989) (to be codified at 29 C.F.R. § 1910.137).

(C) Proposed Rule OSHA Safety and Health Regulations for General Industry, 54 Fed. Reg. 5009-5024 (1989) (to be codified at 29 C.F.R. § 1910.269).

(2) In interpreting these regulations, the Arkansas Department of Labor may rely on any Interpretive Bulletins or other published comments of the Occupational Safety and Health Administration, U.S. Department of Labor.

(d) REVIEW AND UPDATE.

(1) These regulations shall be reviewed at least annually by the Administrator of the Safety Division of the Arkansas Department of Labor. If there has been any change in the federal

regulations or proposed regulations adopted by reference herein, the Administrator shall make any appropriate recommendation to the Director of the Arkansas Department of Labor for revision of these regulations.

(2) Modification or amendment of these regulations shall be made in compliance with the Arkansas Administrative Procedures Act, Arkansas Code 25-15-201 et seq.

(e) PUBLIC INFORMATION.

Within six (6) months of the effective date of these regulations, the Safety Division of the Arkansas Department of Labor shall develop and make available to the public an informative publication written in non-technical terms, explaining the requirements of these regulations. This information may be published in conjunction with Safety Code No. 11.

(f) The effective date of these regulations shall be the 1st day of October, 1993.

APPENDIX A TO CODE 11 - 29 C.F.R. §1910.269 ELECTRIC POWER GENERATION, TRANSMISSION, AND DISTRIBUTION

NOTE: OSHA is staying the enforcement of the following paragraphs of §1910.269 until November 1, 1994: (b)(1)(ii), (d) except for (d)(2)(i) and (d)(2)(iii), (e)(2), (e)(3), (j)(2)(iii), (l)(6)(iii), (m), (n)(3), (n)(4)(ii), (n)(8), (o) except for (o)(2)(i), (r)(1)(vi), (u)(1), (u)(4), (u)(5). OSHA is also staying the enforcement of paragraphs (n)(6) and (n)(7) of §1910.269 until November 1, 1994, but only insofar as they apply to lines and equipment operated at 600 volts or less. Further, OSHA is staying the enforcement of paragraph (v)(11)(xii) of §1910.269 until February 1, 1996.

(a) GENERAL - (1) APPLICATION. (i) This section covers the operation and maintenance of electric power generation, control, transformation, transmission, and distribution lines and equipment. These provisions apply to:

(A) Power generation, transmission and distribution installations, including related equipment for the purpose of communication or metering, which are accessible only to qualified employees;

NOTE: The types of installations covered by this paragraph include the generation, transmission, and distribution installations of electric utilities, as well as equivalent installations of industrial establishments. Supplementary electric generating equipment that is used to supply a workplace for emergency, standby, or similar purposes only is covered under Subpart S of this Part. (See paragraph (a)(1)(ii)(B) of this section.)

(B) Other installations at an electric power generating station, as follows:

(1) Fuel and ash handling and processing installations, such as coal conveyors,

(2) Water and steam installations, such as penstocks, pipelines, and tanks, providing a source of energy for electric generators, and

(3) Chlorine and hydrogen systems;

(C) Test sites where electrical testing involving temporary measurements associated with electric power generation, transmission, and distribution is performed in laboratories, in the field, in substations, and on lines, as opposed to metering, relaying, and routine line work;

(D) Work on or directly associated with the installations covered in paragraphs (a)(1)(i)(A) through (a)(1)(i)(C) of this section; and

(E) Line-clearance tree-trimming operations, as follows:

(1) Entire §1910.269 of this Part, except paragraph (r)(1) of this section, applies to line-clearance tree-trimming operations performed by qualified employees (those who are knowledgeable in the construction and operation of electric power generation, transmission, or distribution equipment involved, along with the associated hazards).

(2) Paragraphs (a)(2),(b),(c), (g), (k), (p), and (r) of this section apply to line-clearance tree-trimming operations performed by line-clearance tree trimmers who are not qualified employees.

(ii) Notwithstanding paragraph (a)(1)(i) of this section, §1910.269 of this Part does not apply:

(A) To construction work, as defined in §1910.12 of this Part; or

(B) To electrical installations, electrical safety-related work practices, or electrical maintenance considerations covered by Subpart S of this Part.

NOTE 1: Work practices conforming to §§1910.332 through 1910.335 of this Part are considered as complying with the electrical safety-related work practice requirements of this section identified in Table 1 of Appendix A-2 to this section, provided the work is being performed on a generation or distribution installation meeting §§1910.303 through 1910.308 of this Part. This table also identifies provisions in this section that apply to work by qualified persons directly on or associated with installations of electric power generation, transmission, and distribution lines or equipment, regardless of compliance with §§1910.332 through 1910.335 of this Part.

NOTE 2: Work practices performed by qualified persons and conforming to §1910.269 of this Part are considered as complying with §§1910.333(c) and 1910.335 of this Part.

(iii) This section applies in addition to all other applicable standards contained in this Part 1910. Specific references in this section to other sections of Part 1910 are provided for emphasis only.

(2) TRAINING. (i) Employees shall be trained in and familiar with the safety-related work practices, safety procedures, and other safety requirements in this section that pertain to their respective job assignments. Employees shall also be trained in and familiar with any other safety practices, including applicable emergency procedures (such as pole top and manhole rescue), that are not specifically addressed by this section but that are related to their work and are necessary for their safety.

(ii) Qualified employees shall also be trained and competent in:

(A) The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment,

(B) The skills and techniques necessary to determine the nominal voltage of exposed live parts,

(C) The minimum approach distances specified in this section corresponding to the voltages to which the qualified employee will be exposed, and

(D) The proper use of the special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools for working on or near exposed energized parts of electric equipment.

NOTE: For the purposes of this section, a person must have this training in order to be considered a qualified person.

(iii) The employer shall determine, through regular supervision and through inspections conducted on at least an annual basis, that each employee is complying with the safety-related work practices required by this section.

(iv) An employee shall receive additional training (or retraining) under any of the following conditions:

(A) If the supervision and annual inspections required by paragraph (a)(2)(iii) of this section indicate that the employee is not complying with the safety-related work practices required by this section, or

(B) If new technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices that are different from those which the employee would normally use, or

(C) If he or she must employ safety-related work practices that are not normally used during his or her regular job duties.

NOTE: OSHA would consider tasks that are performed less often than once per year to necessitate retraining before the performance of the work practices involved.

(v) The training required by paragraph (a)(2) of this section shall be of the classroom or on-the-job type.

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

(vii) The employer shall certify that each employee has received the training required by paragraph (a)(2) of this section. This certification shall be made when the employee demonstrates proficiency in the work practices involved and shall be maintained for the duration of the employee's employment.

NOTE: Employment records that indicate that an employee has received the required training are an acceptable means of meeting this requirement.

(3) EXISTING CONDITIONS. Existing conditions related to the safety of the work to be performed shall be determined before work on or near electric lines or equipment is started. Such conditions include, but are not limited to, the nominal voltages of lines and equipment, the maximum switching transient voltages, the presence of hazardous induced voltages, the presence and condition of protective grounds and equipment grounding conductors, the condition of poles, environmental conditions relative to safety, and the locations of circuits and equipment, including power and communication lines and fire protective signaling circuits.

(b) MEDICAL SERVICES AND FIRST AID. The employer shall provide medical services and first

aid as required in §1910.151 of this Part. In addition to the requirements of §1910.151 of this Part, the following requirements also apply:

(1) **CARDIOPULMONARY RESUSCITATION AND FIRST AID TRAINING.** When employees are performing work on or associated with exposed lines or equipment energized at 50 volts or more, persons trained in first aid including cardiopulmonary resuscitation (CPR) shall be available as follows:

(i) For field work involving two or more employees at a work location, at least two trained persons shall be available. However, only one trained person need be available if all new employees are trained in first aid, including CPR, within 3 months of their hiring dates.

(ii) For fixed work locations such as generating stations, the number of trained persons available shall be sufficient to ensure that each employee exposed to electric shock can be reached within 4 minutes by a trained person. However, where the existing number of employees is insufficient to meet this requirement (at a remote substation, for example), all employees at the work location shall be trained.

(2) **FIRST AID SUPPLIES.** First aid supplies required by §1910.151(b) of this Part shall be placed in weatherproof containers if the supplies could be exposed to the weather.

(3) **FIRST AID KITS.** Each first aid kit shall be maintained, shall be readily available for use, and shall be inspected frequently enough to ensure that expended items are replaced but at least once per year.

(c) **JOB BRIEFING.** The employer shall ensure that the employee in charge conducts a job briefing with the employees involved before they start each job. The briefing shall cover at least the following subjects: hazards associated with the job, work procedures involved, special precautions, energy source controls, and personal protective equipment requirements.

(1) **NUMBER OF BRIEFINGS.** If the work or operations to be performed during the work day or shift are repetitive and similar, at least one job briefing shall be conducted before the start of the first job of each day or shift. Additional job briefings shall be held if significant changes, which might affect the safety of the employees, occur during the course of the work.

(2) **EXTENT OF BRIEFING.** A brief discussion is satisfactory if the work involved is routine and if the employee, by virtue of training and experience, can reasonably be expected to recognize and avoid the hazards involved in the job. A more extensive discussion shall be conducted:

(i) If the work is complicated or particularly hazardous, or

(ii) If the employee cannot be expected to recognize and avoid the hazards involved in the job.

NOTE: The briefing is always required to touch on all the subjects listed in the introductory text to paragraph (c) of this section.

(3) **WORKING ALONE.** An employee working alone need not conduct a job briefing. However, the employer shall ensure that the tasks to be performed are planned as if a briefing were required.

(d) **HAZARDOUS ENERGY CONTROL (LOCKOUT/TAGOUT) PROCEDURES - (1) APPLICATION.** The provisions of paragraph (d) 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 by paragraph (m) of this section.

NOTE 1: 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 §1910.147 and Subpart S of this Part.

NOTE 2: Lockout and tagging procedures that comply with paragraphs (c) through (f) of §1910.147 of this Part will also be deemed to comply with paragraph (d) of this section if the procedures address the hazards covered by paragraph (d) of this section.

(2) **GENERAL.** (i) 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.

(ii) The employer's energy control program under paragraph (d)(2) of this section 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.

(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) After November 1, 1994, 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.

(iii) Procedures shall be developed, documented, and used for the control of potentially hazardous energy covered by paragraph (d) of this section.

(iv) 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; and

(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.

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

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

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

(C) 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.

(D) 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 paragraph (d)(2)(vii) of this section.

(E) The employer shall certify that the inspections required by paragraph (d)(2)(v) of 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.

NOTE: If normal work schedule and operation records demonstrate adequate inspection activity and contain the required information, no additional certification is required.

(vi) 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:

(A) 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.

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

(C) 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.

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

(viii) 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 paragraph (d)(2)(v) 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.

(ix) 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.

(3) PROTECTIVE MATERIALS AND HARDWARE. (i) 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.

(ii) Lockout devices and tagout devices shall be singularly identified; shall be the only devices used for controlling energy; may 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.

(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 non-releasable 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.

NOTE: For specific provisions covering accident prevention tags, see §1910.145 of this Part.

(4) ENERGY ISOLATION. Lockout and tagout device application and removal may only be performed by the authorized employees who are performing the servicing or maintenance.

(5) NOTIFICATION. Affected employees shall be notified by the employer of 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: See also paragraph (d)(7) of this section, which requires that the second notification take place before the machine or equipment is reenergized.

(6) 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:

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

(ii) 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.

(iii) 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.

(iv) 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.

(v) 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.

(vi) 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.

(VII) Before starting work on machines or equipment that have been lockout 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.

(7) 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:

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

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

(iii) 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.

(iv) 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;

(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.

(8) ADDITIONAL REQUIREMENTS. (i) 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 paragraph (d)(7)(i) of this section;

(B) Remove employees from the machine or equipment area in accordance with paragraphs (d)(7)(ii) and (d)(7)(iii) of this section;

(C) Remove the lockout or tagout devices as specified in paragraph (d)(7)(iv) 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 paragraph (d)(6) of this section to continue the servicing or maintenance.

(ii) 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 paragraphs (d)(2)(iii) and (d)(2)(iv) of this section including, but not limited to, the following specific requirements:

(A) 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);

(B) 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;

(C) 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

(D) 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.

(iii) 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.

(iv) Whenever outside servicing personnel are to be engaged in activities covered by paragraph

(d) 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.

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

(A) 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.

(B) The system operator shall place and remove lockout and tagout devices in place of the authorized employee under paragraphs (d)(4), (d)(6)(iv), and (d)(7)(iv) of this section.

(C) 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.

(e) **ENCLOSED SPACES.** This paragraph covers enclosed spaces that may be entered by employees. It does not apply to vented vaults if a determination is made that the ventilation system is operating to protect employees before they enter the space. This paragraph applies to routine entry into enclosed spaces in lieu of the permit-space entry requirements contained in paragraphs (d) through (k) of §1910.146 of this Part. If, after the precautions given in paragraphs (e) and (t) of this section are taken, the hazards remaining in the enclosed space endanger the life of an entrant or could interfere with escape from the space, then entry into the enclosed space shall meet the permit-space entry requirements of paragraphs (d) through (k) of §1910.146 of this Part.

NOTE: Entries into enclosed spaces conducted in accordance with the permit-space entry requirements of paragraphs (d) through (k) of §1910.146 of this Part are considered as complying with paragraph (e) of this section.

(1) **SAFE WORK PRACTICES.** The employer shall ensure the use of safe work practices for entry into and work in enclosed spaces and for rescue of employees from such spaces.

(2) **TRAINING.** Employees who enter enclosed spaces or who serve as attendants shall be trained in the hazards of enclosed space entry, in enclosed space entry procedures, and in enclosed space rescue procedures.

(3) **RESCUE EQUIPMENT.** Employers shall provide equipment to ensure the prompt and safe rescue of employees from the enclosed space.

(4) **EVALUATION OF 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: The evaluation called for in this paragraph may take the form of a check of the conditions expected to 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. A determination must also 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.

(5) **REMOVAL OF COVERS.** When covers are removed from enclosed spaces, the opening shall be promptly guarded by a railing, temporary cover, or other barrier intended to prevent an accidental fall through the opening and to protect employees working in the space from objects entering the space.

(6) **HAZARDOUS ATMOSPHERE.** Employees may not enter any enclosed space while it contains a hazardous atmosphere, unless the entry conforms to the generic permit-required confined spaces standard in §1910.146 of this Part.

NOTE: The term "entry" is defined in §1910.146(b) of this Part.

(7) ATTENDANTS. While work is being performed in the enclosed space, a person with first aid training meeting paragraph (b) of this section shall be immediately available outside the enclosed space to render emergency assistance if there is reason to believe that a hazard may exist in the space or if a hazard exists because of traffic patterns in the area of the opening used for entry. That person 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.

NOTE: See paragraph (t)(3) of this section for additional requirements on attendants for work in manholes.

(8) CALIBRATION OF TEST INSTRUMENTS. Test instruments used to monitor atmospheres in enclosed spaces shall be kept in calibration, with a minimum accuracy of ± 10 percent.

(9) TESTING FOR OXYGEN DEFICIENCY. Before an employee enters an enclosed space, the internal atmosphere shall be tested for oxygen deficiency with a direct-reading meter or similar instrument, capable of collection and immediate analysis of data samples without the need for off-site evaluation. If continuous forced air ventilation is provided, testing is not required provided that the procedures used ensure that employees are not exposed to the hazards posed by oxygen deficiency.

(10) TESTING FOR FLAMMABLE GASES AND VAPORS. Before an employee enters an enclosed space, the internal atmosphere shall be tested for flammable gases and vapors with a direct-reading meter or similar instrument capable of collection and immediate analysis of data samples without the need for off-site evaluation. This test shall be performed after the oxygen testing and ventilation required by paragraph (e)(9) of this section demonstrate that there is sufficient oxygen to ensure the accuracy of the test for flammability.

(11) VENTILATION AND MONITORING. If flammable gases or vapors are detected or if an oxygen deficiency is found, forced air ventilation shall be used to maintain oxygen at a safe level and to prevent a hazardous concentration of flammable gases and vapors from accumulating. A continuous monitoring program to ensure that no increase in flammable gas or vapor concentration occurs may be followed in lieu of ventilation, if flammable gases or vapors are detected at safe levels.

NOTE: See the definition of hazardous atmosphere for guidance in determining whether or not a given concentration of a substance is considered to be hazardous.

(12) SPECIFIC VENTILATION REQUIREMENTS. If continuous forced air ventilation is used, it shall begin before entry is made and shall be maintained long enough to ensure 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.

(13) AIR SUPPLY. The air supply for the continuous forced air ventilation shall be from a clean source and may not increase the hazards in the enclosed space.

(14) OPEN FLAMES. 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.

NOTE: See the definition of hazardous atmosphere for guidance in determining whether or not a given concentration of a substance is considered to be hazardous.

(f) EXCAVATIONS. Excavation operations shall comply with Subpart P of Part 1926 of this chapter.

(g) PERSONAL PROTECTIVE EQUIPMENT - (1) GENERAL. Personal protective equipment shall meet the requirements of Subpart I of this Part.

(2) FALL PROTECTION. (i) Personal fall arrest equipment shall meet the requirements of Subpart E of Part 1926 of this Chapter.

(ii) Body belts and safety straps for work positioning shall meet the requirements of §1926.959 of this Chapter.

(iii) Body belts, safety straps, lanyards, lifelines, and body harnesses shall be inspected before use each day to determine that the equipment is in safe working condition. Defective equipment may not be used.

(iv) Lifelines shall be protected against being cut or abraded.

(v) Fall arrest equipment, work positioning equipment, or travel restricting equipment shall be used by employees working at elevated locations more than 4 feet (1.2 m) above the ground on poles, towers, or similar structures if other fall protection has not been provided. Fall protection equipment is not required to be used by a qualified employee climbing or changing location on poles, towers, or similar structures, unless conditions, such as, but not limited to, ice, high winds, the design of the structure (for example, no provision for holding on with hands), or the presence of contaminants on the structure, could cause the employee to lose his or her grip or footing.

NOTE 1: This paragraph applies to structures that support overhead electric power generation, transmission, and distribution lines and equipment. It does not apply to portions of buildings, such as loading docks, to electric equipment, such as transformers and capacitors, nor to aerial lifts. Requirements for fall protection associated with walking and working surfaces are contained in Subpart D of this Part; requirements for fall protection associated with aerial lifts are contained in §1910.67 of this Part.

NOTE 2: Employees undergoing training are not considered "qualified employees" for the purposes of this provision. Unqualified employees (including trainees) are required to use fall protection any time they are more than 4 feet (1.2 m) above the ground.

(vi) The following requirements apply to personal fall arrest systems:

(A) When stopping or arresting a fall, personal fall arrest systems shall limit the maximum arresting force on an employee to 900 pounds (4 kN) if used with a body belt.

(B) When stopping or arresting a fall, personal fall arrest systems shall limit the maximum arresting force on an employee to 1800 pounds (8 kN) if used with a body harness.

(C) Personal fall arrest systems shall be rigged such that an employee can neither free fall more than 6 feet (1.8 m) nor contact any lower level.

(vii) If vertical lifelines or droplines are used, not more than one employee may be attached to any one lifeline.

(viii) Snaphooks may not be connected to loops made in webbing-type lanyards.

(ix) Snaphooks may not be connected to each other.

(h) LADDERS, PLATFORMS, STEP BOLTS, AND MANHOLE STEPS - (1) GENERAL. Requirements for ladders contained in Subpart D of this Part apply, except as specifically noted in paragraph (h)(2) of this section.

(2) SPECIAL LADDERS AND PLATFORMS. Portable ladders and platforms used on structures or conductors in conjunction with overhead line work need not meet paragraphs (d)(2)(i) and (d)(2)(iii) of §1910.25 of this Part or paragraph (c)(3)(iii) of §1910.26 of this Part. However, these ladders and platforms shall meet the following requirements:

(i) Ladders and platforms shall be secured to prevent their becoming accidentally dislodged.

(ii) Ladders and platforms may not be loaded in excess of the working loads for which they are designed.

(iii) Ladders and platforms may be used only in applications for which they were designed.

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

(3) CONDUCTIVE LADDERS. Portable metal ladders and other portable conductive ladders may not be used near exposed energized lines or equipment. However, in specialized high-voltage work, conductive ladders shall be used where the employer can demonstrate that nonconductive ladders would present a greater hazard than conductive ladders.

(i) HAND AND PORTABLE POWER TOOLS - (1) GENERAL. Paragraph (i)(2) of this section applies to electric equipment connected by cord and plug. Paragraph (i)(3) of this section applies to portable and vehicle-mounted generators used to supply cord-and plug-connected equipment. Paragraph (i)(4) of this section applies to hydraulic and pneumatic tools.

(2) CORD- AND PLUG-CONNECTED EQUIPMENT. (i) Cord-and plug-connected equipment supplied by premises wiring is covered by Subpart S of this Part.

(ii) Any cord-and plug-connected equipment supplied by other than premises wiring shall comply with one of the following in lieu of §1910.243(a)(5) of this Part:

(A) It shall be equipped with a cord containing an equipment grounding conductor connected to the tool frame and to a means for grounding the other end (however, this option may not be used where the introduction of the ground into the work environment increases the hazard to an employee); or

(B) It shall be of the double-insulated type conforming to Subpart S of this Part; or

(C) It shall be connected to the power supply through an isolating transformer with an ungrounded secondary.

(3) PORTABLE AND VEHICLE-MOUNTED GENERATORS. Portable and vehicle-mounted generators used to supply cord- and plug-connected equipment shall meet the following requirements:

(i) The generator may only supply equipment located on the generator or the vehicle and cord-and plug-connected equipment through receptacles mounted on the generator or the vehicle.

(ii) The non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles shall be bonded to the generator frame.

(iii) In the case of vehicle-mounted generators, the frame of the generator shall be bonded to the vehicle frame.

(iv) Any neutral conductor shall be bonded to the generator frame.

(4) HYDRAULIC AND PNEUMATIC TOOLS. (i) Safe operating pressures for hydraulic and pneumatic tools, hoses, valves, pipes, filters, and fittings may not be exceeded.

NOTE: If any hazardous defects are present, no operating pressure would be safe, and the hydraulic or pneumatic equipment involved may not be used. In the absence of defects, the maximum rated operating pressure is the maximum safe pressure.

(ii) A hydraulic or pneumatic tool used where it may contact exposed live parts shall be designed and maintained for such use.

(iii) 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.

NOTE: Hydraulic lines without check valves having a separation of more than 35 feet (10.7 m) between the oil reservoir and the upper end of the hydraulic system promote the formation of a partial vacuum.

(iv) A pneumatic tool used on energized electric lines or equipment or used where it may contact exposed live parts shall provide protection against the accumulation of moisture in the air supply.

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

(vi) Employees may not use any part of their bodies to locate or attempt to stop a hydraulic leak.

(j) LIVE-LINE TOOLS - (1) DESIGN OF TOOLS. Live-line tool rods, tubes, and poles shall be designed and constructed to withstand the following minimum tests:

(i) 100,000 volts per foot (3281 volts per centimeter) of length for 5 minutes if the tool is made of fiberglass-reinforced plastic (FRP), or

(ii) 75,000 volts per foot (2461 volts per centimeter) of length for 3 minutes if the tool is made of wood, or

(iii) Other tests that the employer can demonstrate are equivalent.

NOTE: Live-line tools using rod and tube that meet ASTM F711-89, Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live-Line Tools, conform to paragraph (j)(1)(i) of this section.

(2) CONDITION OF TOOLS. (i) Each live-line tool shall be wiped clean and visually inspected for defects before use each day.

(ii) 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 and examined and tested according to paragraph (j)(2)(iii) of this section before being returned to service.

(iii) Live-line tools used for primary employee protection shall be removed from service every 2 years and whenever required under paragraph (j)(2)(ii) 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 in accordance with paragraphs (j)(2)(iii)(D) and (j)(2)(iii)(E) of this section under the following conditions:

(1) After the tool has been repaired or refinished; and

(2) After the examination if repair or refinishing is not performed, unless the tool is made of FRP rod or foam-filled FRP tube and the employer can demonstrate that the tool has no defects that could cause it to fail in 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:

(1) 75,000 volts per foot (2461 volts per centimeter) of length for 1 minute if the tool is made of fiberglass, or

(2) 50,000 volts per foot (1640 volts per centimeter) of length for 1 minute if the tool is made of wood, or

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

NOTE: Guidelines for the examination, cleaning, repairing, and in-service testing of live-line tools are contained in the Institute of Electrical and Electronics Engineers Guide for In-Service Maintenance and Electrical Testing of Live-Line Tools, IEEE Std. 978-1984.

(k) MATERIALS HANDLING AND STORAGE - (1) GENERAL. Material handling and storage shall conform to the requirements of Subpart N of this Part.

(2) MATERIALS STORAGE NEAR ENERGIZED LINES OR EQUIPMENT. (i) In areas not restricted to qualified persons only, materials or equipment may not be stored closer to energized lines or exposed energized parts of equipment than the following distances plus an amount providing for the maximum sag and side swing of all conductors and providing for the height and movement of material handling equipment:

(A) For lines and equipment energized at 50 kV or less, the distance is 10 feet (305 cm).

(B) For lines and equipment energized at more than 50 kV, the distance is 10 feet (305 cm) plus 4 inches (10 cm) for every 10 kV over 50 kV.

(ii) In areas restricted to qualified employees, material may not be stored within the working space about energized lines or equipment.

NOTE: Requirements for the size of the working space are contained in paragraphs (u)(1) and (v)(3) of this section.

(l) WORKING ON OR NEAR EXPOSED ENERGIZED PARTS. This paragraph applies to work on exposed live parts, or near enough to them, to expose the employee to any hazard they present.

(1) GENERAL. Only qualified employees may work on or with exposed energized lines or parts of equipment. Only qualified employees may work in areas containing unguarded, uninsulated energized lines or parts of equipment operating at 50 volts or more. Electric lines and equipment shall be considered and treated as energized unless the provisions of paragraph (d) or paragraph (m) or this section have been followed.

(i) Except as provided in paragraph (l)(1)(ii) of this section, at least two employees shall be present while the following types of work are being performed:

- (A) Installation, removal, or repair of lines that are energized at more than 600 volts.
- (B) Installation, removal, or repair of deenergized lines if an employee is exposed to contact with other parts energized at more than 600 volts.
- (C) Installation, removal, or repair of equipment, such as transformers, capacitors, and regulators, if an employee is exposed to contact with parts energized at more than 600 volts.
- (D) Work involving the use of mechanical equipment, other than insulated aerial lifts, near parts energized at more than 600 volts, and
- (E) Other work that exposes an employee to electrical hazards greater than or equal to those posed by operations that are specifically listed in paragraphs (l)(1)(i)(A) through (l)(1)(i)(D) of this section.
- (ii) Paragraph (l)(1)(i) of this section does not apply to the following operations:
 - (A) Routine switching of circuits, if the employer can demonstrate that conditions at the site allow this work to be performed safely,
 - (B) Work performed with live-line tools if the employee is positioned so that he or she is neither within reach of nor otherwise exposed to contact with energized parts, and
 - (C) Emergency repairs to the extent necessary to safeguard the general public.
- (2) MINIMUM APPROACH DISTANCES. The employer shall ensure that no employee approaches or takes any conductive object closer to exposed energized parts than set forth in Table R-6 through Table R-10, unless:
 - (i) The employee is insulated from the energized part (insulating gloves or insulating gloves and sleeves worn in accordance with paragraph (l)(3) of this section are considered insulation of the employee only with regard to the energized part upon which work is being performed), or
 - (ii) The energized part is insulated from the employee and from any other conductive object at a different potential, or
 - (iii) The employee is insulated from any other exposed conductive object, as during live-line bare-hand work.

NOTE: Paragraphs (u)(5)(i) and (v)(5)(i) of this section contain requirements for the guarding and isolation of live parts. Parts of electric circuits that meet these two provisions are not considered as "exposed" unless a guard is removed or an employee enters the space intended to provide isolation from the live parts.

- (3) TYPE OF INSULATION. If the employee is to be insulated from energized parts by the use of insulating gloves (under paragraph (l)(2)(i) of this section), insulating sleeves shall also be used. However, insulating sleeves need not be used under the following conditions:
 - (i) If exposed energized parts on which work is not being performed are insulated from the employee and
 - (ii) If such insulation is placed from a position not exposing the employee's upper arm to contact with other energized parts.
- (4) WORKING POSITION. The employer shall ensure that each employee, to the extent that other safety-related conditions at the worksite permit, works in a position from which a slip or shock will not bring the employee's body into contact with exposed, uninsulated parts energized at a potential different from the employee.
- (5) MAKING CONNECTIONS. The employer shall ensure that connections are made as follows:
 - (i) 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;
 - (ii) 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
 - (iii) When lines or equipment are connected to or disconnected from energized circuits, loose conductors shall be kept away from exposed energized parts.
- (6) APPAREL. (i) When work is performed within reaching distance of exposed energized parts of equipment, the employer shall ensure that each employee removes or renders nonconductive all exposed conductive articles, such as key or watch chains, rings, or wrist watches or bands, unless such articles do not increase the hazards associated with contact with the energized parts.
 - (ii) The employer shall train each employee who is exposed to the hazards of flames or electric arcs in the hazards involved.

(iii) 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.

NOTE: Clothing made from the following types of fabrics, either alone or in blends, is prohibited by this paragraph, unless the employer can demonstrate that the fabric has been treated to withstand the conditions that may be encountered or that the clothing is worn in such a manner as to eliminate the hazard involved: acetate, nylon, polyester, rayon.

(7) FUSE HANDLING. When fuses must be installed or removed 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 tools or gloves rated for the voltage are used. When expulsion-type fuses are installed with one or both terminals energized at more than 300 volts, the employer shall ensure that each employee wears eye protection meeting the requirements of Subpart I of this Part, uses a tool rated for the voltage, and is clear of the exhaust path of the fuse barrel.

(8) COVERED (NONINSULATED) CONDUCTORS. The requirements of this section which pertain to the hazards of exposed live parts also apply when work is performed in the proximity of covered (noninsulated) wires.

(9) NONCURRENT-CARRYING METAL PARTS. Noncurrent-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 they are exposed, unless the employer inspects the installation and determines that these parts are grounded before work is performed.

(10) OPENING CIRCUITS UNDER LOAD. Devices used to open circuits under load conditions shall be designed to interrupt the current involved.

TABLE R-6. - AC LIVE-LINE WORK MINIMUM APPROACH DISTANCE

Nominal voltage in kilovolts phase to phase	Distance			
	Phase to ground exposure (ft-in) (m)		Phase to phase exposure (ft-in) (m)	
0.05 to 1.0	(⁴)	(⁴)	(⁴)	(⁴)
1.1 to 15.0	2-1	0.64	2-2	0.66
15.1 to 36.0	2-4	0.72	2-7	0.77
36.1 to 46.0	2-7	0.77	2-10	0.85
46.1 to 72.5	3-0	0.90	3-6	1.05
72.6 to 121	3-2	0.95	4-3	1.29
138 to 145	3-7	1.09	4-11	1.50
161 to 169	4-0	1.22	5-8	1.71
230 to 242	5-3	1.59	7-6	2.27
345 to 362	8-6	2.59	12-6	3.80
500 to 550	11-3	3.42	18-1	5.50
765 to 800	14-11	4.53	26-0	7.91

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.

NOTE 3: See Appendix B to this section for information on how the minimum approach distances listed in the tables were derived.

⁴Avoid contact.

TABLE R-7. - AC LIVE-LINE WORK MINIMUM APPROACH DISTANCE WITH OVERVOLTAGE FACTOR
PHASE-TO-GROUND EXPOSURE

Maximum anticipated per-unit transient overvoltage	Distance in feet-inches Maximum phase-to-phase voltage in kilovolts						
	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	
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 R-6 applies otherwise.

NOTE 2: The distances specified in this table are the air, bare-hand, and live-line tool distances.

NOTE 3: See Appendix B to this section for information on how the minimum approach distances listed in the tables were derived and on how to calculate revised minimum approach distances based on the control of transient overvoltages.

TABLE R-8. - AC LIVE-LINE WORK MINIMUM APPROACH DISTANCE WITH OVERVOLTAGE FACTOR
PHASE-TO-PHASE EXPOSURE

Maximum anticipated per-unit transient overvoltage	Distance in feet-inches Maximum phase-to-phase voltage in kilovolts						
	121	145	169	242	362	552	800
1.5						7-4	12-1
1.6						8-9	14-6
1.7						10-2	17-2
1.8						11-7	19-11
1.9						13-2	22-11
2.0	3-7	4-1	4-8	6-1	8-7	14-10	26-0
2.1	3-7	4-2	4-9	6-3	8-10	15-7	
2.2	3-8	4-3	4-10	6-4	9-2	16-4	
2.3	3-9	4-4	4-11	6-6	9-6	17-2	
2.4	3-10	4-5	5-0	6-7	9-11	18-1	
2.5	3-11	4-6	5-2	6-9	10-4		
2.6	4-0	4-7	5-3	6-11	10-9		
2.7	4-1	4-8	5-4	7-0	11-2		
2.8	4-1	4-9	5-5	7-2	11-7		
2.9	4-2	4-10	5-6	7-4	12-1		
3.0	4-3	4-11	5-8	7-6	12-6		

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 R-6 applies otherwise.

NOTE 2: The distances specified in this table are the air, bare-hand, and live-line tool distances.

NOTE 3: See Appendix B to this section for information on how the minimum approach distances listed in the tables were derived and on how to calculate revised minimum approach distances based on the control of transient overvoltages.

TABLE R-9. - DC LIVE-LINE WORK MINIMUM APPROACH DISTANCE WITH OVERVOLTAGE FACTOR

Maximum anticipated per-	Distance in feet-inches Maximum line-to-ground voltage in kilovolts
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unit transient 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 distances specified in this table are the air, bare-hand and live-line tool distances.

TABLE R-10. - ALTITUDE CORRECTION FACTOR

Attitude		Correction factor
ft	m	
3000	900	1.00
4000	1200	1.02
5000	1500	1.05
6000	1800	1.08
7000	2100	1.11
8000	2400	1.14
9000	2700	1.17
10000	3000	1.20
12000	3600	1.25
14000	4200	1.30
16000	4800	1.35
18000	5400	1.39
20000	6000	1.44

NOTE: If the work is performed at elevations greater than 3000 ft (900 m) above mean sea level, the minimum approach distance shall be determined by multiplying the distances in Table R-6 through Table R-9 by the correction factor corresponding to the altitude at which work is performed.

(m) DEENERGIZING LINES AND EQUIPMENT FOR EMPLOYEE PROTECTION - (1) APPLICATION. Paragraph (m) of this section applies to the deenergizing of transmission and distribution lines and equipment for the purpose of protecting employees. Control of hazardous energy sources used in the generation of electric energy is covered in paragraph (d) of this section. Conductors and parts of electric

equipment that have been deenergized under procedures other than those required by paragraph (d) or (m) of this section, as applicable, shall be treated as energized.

(2) GENERAL. (i) If a system operator is in charge of the lines or equipment and their means of disconnection, all of the requirements of paragraph (m)(3) of this section shall be observed, in the order given.

(ii) If no system operator is in charge of the lines or equipment and their means of disconnection, one employee in the crew shall be designated as being in charge of the clearance. All of the requirements of paragraph (m)(3) of this section apply, in the order given, except as provided in paragraph (m)(2)(iii) of this section. The employee in charge of the clearance shall take the place of the system operator, as necessary.

(iii) 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, paragraphs (m)(3)(i), (m)(3)(iii), (m)(3)(iv), (m)(3)(viii), and (m)(3)(xii) of this section do not apply. Additionally, tags required by the remaining provisions of paragraph (m)(3) of this section need not be used.

(iv) Any disconnecting means that are accessible to persons outside the employer's control (for example, the general public) shall be rendered inoperable while they are open for the purpose of protecting employees.

(3) DEENERGIZING LINES AND EQUIPMENT. (i) A designated employee shall make a request of the system operator to have the particular section of line or equipment deenergized. The designated employee becomes the employee in charge (as this term is used in paragraph (m)(3) of this section) and is responsible for the clearance.

(ii) 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 shall be opened. Such means shall be rendered inoperable, unless its design does not so permit, and tagged to indicate that employees are at work.

(iii) Automatically and remotely controlled switches that could cause the opened disconnecting means to close shall also be tagged at the point of control. The automatic or remote control feature shall be rendered inoperable, unless its design does not so permit.

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

(v) After the applicable requirements in paragraphs (m)(3)(i) through (m)(3)(iv) of this section have been followed and the employee in charge of the work has been given a clearance by the system operator, the lines and equipment to be worked shall be tested to ensure that they are deenergized.

(vi) Protective grounds shall be installed as required by paragraph (n) of this section.

(vii) After the applicable requirements of paragraphs (m)(3)(i) through (m)(3)(vi) of this section have been followed, the lines and equipment involved may be worked as deenergized.

(viii) If two or more independent crews will be working on the same lines or equipment, each crew shall independently comply with the requirements in paragraph (m)(3) of this section.

(ix) To transfer the clearance, the employee in charge (or, if the employee in charge is forced to leave the worksite due to illness or other emergency, the employee's supervisor) shall inform the system operator; employees in the crew shall be informed of the transfer; and the new employee in charge shall be responsible for the clearance.

(x) To release a clearance, the employee in charge shall:

(A) Notify employees under his or her direction that the clearance is to be released;

(B) Determine that all employees in the crew are clear of the lines and equipment;

(C) Determine that all protective grounds installed by the crew have been removed; and

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

(xi) The person releasing a clearance shall be the same person that requested the clearance, unless responsibility has been transferred under paragraph (m)(3)(ix) of this section.

(xii) Tags may not be removed unless the associated clearance has been released under paragraph (m)(3)(x) of this section.

(xiii) Only after all protective grounds have been removed, after all crews working on the lines or equipment have released their clearances, after all employees are clear of the lines and equipment, and after all protective tags have been removed from a given point of disconnection, may action be initiated to reenergize the lines or equipment at that point of disconnection.

(n) GROUNDING FOR THE PROTECTION OF EMPLOYEES - (1) APPLICATION. Paragraph

(n) of this section applies to the grounding of transmission and distribution lines and equipment for the purpose of protecting employees. Paragraph (n)(4) of this section also applies to the protective grounding of other equipment as required elsewhere in this section.

(2) GENERAL. For the employee to work lines or equipment as deenergized, the lines or equipment shall be deenergized under the provisions of paragraph (m) of this section and shall be grounded as specified in paragraphs (n)(3) through (n)(9) 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 than working without grounds, the lines and equipment may be treated as deenergized provided all the following conditions are met:

(i) The lines and equipment have been deenergized under the provisions of paragraph (m) of this section.

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

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

(3) EQUIPOTENTIAL ZONE. 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.

(4) PROTECTIVE GROUNDING EQUIPMENT. (i) Protective grounding equipment shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault. This equipment shall have an ampacity greater than or equal to that 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 F855-1990.

(ii) Protective grounds shall have an impedance low enough to cause immediate operation of protective devices in case of accidental energizing of the lines or equipment.

(5) TESTING. Before any ground is installed, lines and equipment shall be tested and found absent of nominal voltage, unless a previously installed ground is present.

(6) ORDER OF CONNECTION. When a ground is to be attached to a line or to equipment, the ground-end connection shall be attached first, and then the other end shall be attached by means of a live-line tool.

(7) ORDER OF REMOVAL. When a ground is to be removed, the grounding device shall be removed from the line or equipment using a live-line tool before the ground-end connection is removed.

(8) ADDITIONAL PRECAUTIONS. When work is performed on a cable at a location remote from the cable terminal, the cable may not be grounded at the cable terminal if there is a possibility of hazardous transfer of potential should a fault occur.

(9) REMOVAL OF GROUNDS FOR TEST. Grounds may be removed temporarily during tests. During the test procedure, the employer shall ensure that each employee uses insulating equipment and is isolated from any hazards involved, and the employer shall institute any additional measures as may be necessary to protect each exposed employee in case the previously grounded lines and equipment become energized.

(o) TESTING AND TESTS FACILITIES - (1) APPLICATION. Paragraph (o) of 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 utilizing high voltage, high power, or combinations of both, and not to testing involving continuous measurements as in routine metering, relaying, and normal line work.

NOTE: Routine inspection and maintenance measurements made by qualified employees are considered to be routine line work and are not included in the scope of paragraph (o) of this section, as long as the hazards related to the use of intrinsic high-voltage and high-power sources require only the normal precautions associated with routine operation and maintenance work required in the other paragraphs of this section. Two typical examples of such excluded test work procedures are "phasing-out" testing and testing for a "no-voltage" condition.

(2) GENERAL REQUIREMENTS. (i) 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, as a minimum, test area guarding, grounding, and the safe use of measuring and control circuits. A means providing for periodic safety checks of field test areas shall also be included. (See paragraph (o)(6) of this section.)

(ii) Employees shall be trained in safe work practices upon their initial assignment to the test area, with periodic reviews and updates provided as required by paragraph (a)(2) of this section.

(3) GUARDING OF TEST AREAS. (i) Permanent test areas shall be guarded by walls, fences, or barriers designed to keep employees out of the test areas.

(ii) In field testing, or at a temporary test site where permanent fences and gates are not provided, one of the following means shall be used to prevent unauthorized employees from entering:

(A) The test area shall be guarded by the use of distinctively colored safety tape that is supported approximately waist high and to which safety signs are attached.

(B) The test area shall be guarded by a barrier or barricade that limits access to the test area to a degree equivalent, physically and visually, to the barricade specified in paragraph (o)(3)((ii))(A) of this section, or

(C) The test area shall be guarded by one or more test observers stationed so that the entire area can be monitored.

(iii) The barriers required by paragraph (o)(3)(ii) of this section shall be removed when the protection they provide is no longer needed.

(iv) Guarding shall be provided within test areas to control access to test equipment or to apparatus under test that may become energized as part of the testing by either direct or inductive coupling, in order to prevent accidental employee contact with energized parts.

(4) GROUNDING PRACTICES. (i) The employer shall establish and implement safe grounding practices for the test facility.

(A) All conductive parts accessible to the test operator during the time the equipment is operating at high voltage shall be maintained at ground potential except for portions of the equipment that are isolated from the test operator by guarding.

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

(ii) Visible grounds shall be applied, either automatically or manually with properly insulated tools, to the high-voltage circuits after they are deenergized and before work is performed on the circuit or item or apparatus under test. Common ground connections shall be solidly connected to the test equipment and the apparatus under test.

(iii) In high-power testing, an isolated ground-return conductor system shall be provided so that no intentional passage of current, with its attendant voltage rise, can occur in the ground grid or in the earth. However, an isolated ground-return conductor need not be provided if the employer can demonstrate that both the following conditions are met:

(A) An isolated ground-return conductor cannot be provided due to the distance of the test site from the electric energy source, and

(B) Employees are protected from any hazardous step and touch potentials that may develop during the test.

NOTE: See Appendix C to this section for information on measures that can be taken to protect employees from hazardous step and touch potentials.

(iv) In tests in which grounding of test equipment by means of the equipment grounding conductor located in the equipment power cord cannot be used due to increased hazards to test personnel or the prevention of satisfactory measurements, a ground that the employer can demonstrate affords equivalent safety shall be provided, and the safety ground shall be clearly indicated in the test set-up.

(v) When the test area is entered after equipment is deenergized, a ground shall be placed on the high-voltage terminal and any other exposed terminals.

(A) High capacitance equipment or apparatus shall be discharged through a resistor rated for the

available energy.

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

(vi) If a test trailer or test vehicle is used in field testing, its chassis shall be grounded. Protection against hazardous touch potentials with respect to the vehicle, instrument panels, and other conductive parts accessible to employees shall be provided by bonding, insulation, or isolation.

(5) CONTROL AND MEASURING CIRCUITS. (i) Control wiring, meter connections, test leads and cables may not be run from a test area unless they are contained in a grounded metallic sheath and terminated in a grounded metallic enclosure or unless other precautions are taken that the employer can demonstrate as ensuring equivalent safety.

(ii) Meters and other instruments with accessible terminals or parts shall be isolated from test personnel to protect against hazards arising from such terminals and parts becoming energized during testing. If this isolation is provided by locating test equipment in metal compartments with viewing windows, interlocks shall be provided to interrupt the power supply if the compartment cover is opened.

(iii) The routing and connections of temporary wiring shall be made secure against damage, accidental interruptions and other hazards. To the maximum extent possible, signal, control, ground, and power cables shall be kept separate.

(iv) If employees 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.

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

(ii) 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) That barriers and guards are in workable condition and are properly placed to isolate hazardous areas;

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

(C) That test power disconnects are clearly marked and readily available in an emergency;

(D) That ground connections are clearly identifiable;

(E) That personal protective equipment is provided and used as required by Subpart I of this Part and by this section; and

(F) That signal, ground, and power cables are properly separated.

(p) MECHANICAL EQUIPMENT - (1) GENERAL REQUIREMENTS. (i) The critical safety components of mechanical elevating and rotating equipment shall receive a thorough visual inspection before use on each shift.

NOTE: Critical safety components of mechanical elevating and rotating equipment are components whose failure would result in a free fall or free rotation of the boom.

(ii) No vehicular equipment having an obstructed view to the rear may be operated on off-highway jobsites where any employee is exposed to the hazards created by the moving vehicle, unless:

(A) The vehicle has a reverse signal alarm audible above the surrounding noise level, or

(B) The vehicle is backed up only when a designated employee signals that it is safe to do so.

(iii) The operator of an electric line truck may not leave his or her position at the controls while a load is suspended, unless the employer can demonstrate that no employee (including the operator) might be endangered.

(iv) Rubber-tired, self-propelled scrapers, rubber-tired front-end loaders, rubber-tired dozers, wheel-type agricultural and industrial tractors, crawler-type tractors, crawler-type loaders, and motor graders, with or without attachments, shall have roll-over protective structures that meet the requirements of Subpart W of Part 1926 of this chapter.

(2) OUTRIGGERS. (i) Vehicular equipment, if provided with outriggers, shall be operated with the outriggers extended and firmly set as necessary for the stability of the specific configuration of the equipment. Outriggers may not be extended or retracted outside of clear view of the operator unless all

employees are outside the range of possible equipment motion.

(ii) If the work area or the terrain precludes the use of outriggers, the equipment may be operated only within its maximum load ratings for the particular configuration of the equipment without outriggers.

(3) APPLIED LOADS. Mechanical equipment used to lift or move lines or other material shall be used within its maximum load rating and other design limitations for the conditions under which the work is being performed.

(4) OPERATIONS NEAR ENERGIZED LINES OR EQUIPMENT. (i) Mechanical equipment shall be operated so that the minimum approach distances of Table R-6 through Table R-10 are maintained from exposed energized lines and equipment. However, the insulated portion of an aerial lift operated by a qualified employee in the lift is exempt from this requirement.

(ii) A designated employee other than the equipment operator shall observe the approach distance to exposed lines and equipment and give timely warnings before the minimum approach distance required by paragraph (p)(4)(i) is reached, unless the employer can demonstrate that the operator can accurately determine that the minimum approach distance is being maintained.

(iii) If, during operation of the mechanical equipment, the equipment could become energized, the operation shall also comply with at least one of paragraphs (p)(4)(iii)(A) through (p)(4)(iii)(C) of this section.

(A) The energized lines exposed to contact shall be covered with insulating protective material that will withstand the type of contact that might be made during the operation.

(B) The equipment shall be insulated for the voltage involved. The equipment shall be positioned so that its uninsulated portions cannot approach the lines or equipment any closer than the minimum approach distances specified in Table R-6 through Table R-10.

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

- (1) Using the best available ground to minimize the time the lines remain energized,
- (2) Bonding equipment together to minimize potential differences,
- (3) Providing ground mats to extend areas of equipotential, and
- (4) Employing insulating protective equipment or barricades to guard against any remaining hazardous potential differences.

NOTE: Appendix C to this section contains information on hazardous step and touch potentials and on methods of protecting employees from hazards resulting from such potentials.

(Q) OVERHEAD LINES. This paragraph provides additional requirements for work performed on or near overhead lines and equipment.

(1) GENERAL. (i) Before elevated structures, such as poles or towers, are subjected to such stresses as climbing or the installation or removal of equipment may impose, the employer shall ascertain that the structures are capable of sustaining the additional or unbalanced stresses. If the pole or other structure cannot withstand the loads which will be imposed, it shall be braced or otherwise supported so as to prevent failure.

NOTE: Appendix D to this section contains test methods that can be used in ascertaining whether a wood pole is capable of sustaining the forces that would be imposed by an employee climbing the pole. This paragraph also requires the employer to ascertain that the pole can sustain all other forces that will be imposed by the work to be performed.

(ii) When poles are set, moved, or removed near exposed energized overhead conductors, the pole may not contact the conductors.

(iii) 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.

(iv) To protect employees from falling into holes into which poles are to be placed, the holes shall

be attended by employees or physically guarded whenever anyone is working nearby.

(2) **INSTALLING AND REMOVING OVERHEAD LINES.** The following provisions apply to the installation and removal of overhead conductors or cable.

(i) The employer shall use the tension stringing method, barriers, or other equivalent measures to minimize the possibility that conductors and cables being installed or removed will contact energized power lines or equipment.

(ii) The protective measures required by paragraph (p)(4)(iii) of this section for mechanical equipment shall also be provided for conductors, cables, and pulling and tensioning equipment when the conductor or cable is being installed or removed close enough to energized conductors that any of the following failures could energize the pulling or tensioning equipment or the wire or cable being installed or removed:

- (A) Failure of the pulling or tensioning equipment,
- (B) Failure of the wire or cable being pulled, or
- (C) Failure of the previously installed lines or equipment.

(iii) If the conductors being installed or removed cross over energized conductors in excess of 600 volts and if the design of the circuit-interrupting devices protecting the lines so permits, the automatic-reclosing feature of these devices shall be made inoperative.

(iv) Before lines are installed parallel to existing energized lines, the employer shall make a determination of the approximate voltage to be induced in the new lines, or work shall proceed on the assumption that the induced voltage is hazardous. Unless the employer can demonstrate that the lines being installed are not subject to the induction of a hazardous voltage or unless the lines are treated as energized, the following requirements also apply:

(A) Each bare conductor shall be grounded in increments so that no point along the conductor is more than 2 miles (3.22 km) from a ground.

(B) The grounds required in paragraph (q)(2)(iv)(A) of this section shall be left in place until the conductor installation is completed between dead ends.

(C) The grounds required in paragraph (q)(2)(iv)(A) of this section shall be removed as the last phase of aerial cleanup.

(D) If employees are working on bare conductors, grounds shall also be installed at each location where these employees are working, and grounds shall be installed at all open dead-end or catch-off points or the next adjacent structure.

(E) If two bare conductors are to be spliced, the conductors shall be bonded and grounded before being spliced.

(v) Reel handling equipment, including pulling and tensioning devices, shall be in safe operating condition and shall be leveled and aligned.

(vi) Load ratings of stringing lines, pulling lines, conductor grips, loadbearing hardware and accessories, rigging, and hoists may not be exceeded.

(vii) Pulling lines and accessories shall be repaired or replaced when defective.

(viii) Conductor grips may not be used on wire rope, unless the grip is specifically designed for this application.

(ix) Reliable communications, through two-way radios or other equivalent means, shall be maintained between the reel tender and the pulling rig operator.

(x) The pulling rig may only be operated when it is safe to do so.

NOTE: Examples of unsafe conditions include employees in locations prohibited by paragraph (q)(2)(xi) of this section, conductor and pulling line hang-ups, and slipping of the conductor grip.

(xi) While the conductor or pulling line is being pulled (in motion) with a power-driven device, employees are not permitted directly under overhead operations or on the cross arm, except as necessary to guide the stringing sock or board over or through the stringing sheave.

(3) **LIVE-LINE BARE-HAND WORK.** In addition to other applicable provisions contained in this section, the following requirements apply to live-line bare-hand work:

(i) Before using or supervising the use of the live-line bare-hand technique on energized circuits, employees shall be trained in the technique and in the safety requirements of paragraph (q)(3) of this section.

Employees shall receive refresher training as required by paragraph (a)(2) of this section.

(ii) Before any employee uses the live-line bare-hand technique on energized high-voltage conductors or parts, the following information shall be ascertained:

(A) The nominal voltage rating of the circuit on which the work is to be performed,

(B) The minimum approach distances to ground of lines and other energized parts on which work is to be performed, and

(C) The voltage limitations of equipment to be used.

(iii) The insulated equipment, insulated tools, and aerial devices and platforms used shall be designed, tested, and intended for live-line bare-hand work. Tools and equipment shall be kept clean and dry while they are in use.

(iv) The automatic-reclosing feature of circuit-interrupting devices protecting the lines shall be made inoperative, if the design of the devices permits.

(v) Work may not be performed when adverse weather conditions would make the work hazardous even after the work practices required by this section are employed. Additionally, work may not be performed when winds reduce the phase-to-phase or phase-to-ground minimum approach distances at the work location below that specified in paragraph (q)(3)(xiii) of this section, unless the grounded objects and other lines and equipment are covered by insulating guards.

NOTE: Thunderstorms in the immediate vicinity, high winds, snow storms, and ice storms are examples of adverse weather conditions that are presumed to make live-line bare-hand work too hazardous to perform safely.

(vi) A conductive bucket liner or other conductive device shall be provided for bonding the insulated aerial device to the energized line or equipment.

(A) The employee shall be connected to the bucket liner or other conductive device by the use of conductive shoes, leg clips, or other means.

(B) Where differences in potentials at the worksite pose a hazard to employees, electrostatic shielding designed for the voltage being worked shall be provided.

(vii) Before the employee contacts the energized part, the conductive bucket liner or other conductive device shall be bonded to the energized conductor by means of a positive connection. This connection shall remain attached to the energized conductor until the work on the energized circuit is completed.

(viii) Aerial lifts to be used for live-line bare-hand work shall have dual controls (lower and upper) as follows:

(A) The upper controls shall be within easy reach of the employee in the bucket. On a two-bucket-type lift, access to the controls shall be within easy reach from either bucket.

(B) The lower set of controls shall be located near the base of the boom, and they shall be so designed that they can override operation of the equipment at any time.

(ix) Lower (ground-level) lift controls may not be operated with an employee in the lift, except in case of emergency.

(x) Before employees are elevated into the work position, all controls (ground level and bucket) shall be checked to determine that they are in proper working condition.

(xi) Before the boom of an aerial lift is elevated, the body of the truck shall be grounded, or the body of the truck shall be barricaded and treated as energized.

(xii) A boom-current test shall be made before work is started each day, each time during the day when higher voltage is encountered, and when changed conditions indicate a need for an additional test. This test shall consist of placing the bucket in contact with an energized source equal to the voltage to be encountered for a minimum of 3 minutes. The leakage current may not exceed 1 microampere per kilovolt of nominal phase-to-ground voltage. Work from the aerial lift shall be immediately suspended upon indication of a malfunction in the equipment.

(xiii) The minimum approach distances specified in Table R-6 through Table R-10 shall be maintained from all grounded objects and from lines and equipment at a potential different from that to which the live-line bare-hand equipment is bonded, unless such grounded objects and other lines and equipment are covered by insulating guards.

(xiv) While an employee is approaching, leaving, or bonding to an energized circuit, the minimum approach distances in Table R-6 through Table R-10 shall be maintained between the employee and any grounded parts, including the lower boom and portions of the truck.

(xv) While the bucket is positioned alongside an energized bushing or insulator string, the phase-to-ground minimum approach distances of Table R-6 through Table R-10 shall be maintained between all parts of the bucket and the grounded end of the bushing or insulator string or any other grounded surface.

(xvi) Hand lines may not be used between the bucket and the boom or between the bucket and the ground. However, non-conductive-type hand lines may be used from conductor to ground if not supported from the bucket. Ropes used for live-line bare-hand work may not be used for other purposes.

(xvii) Uninsulated equipment or material may not be passed between a pole or structure and an aerial lift while an employee working from the bucket is bonded to an energized part.

(xviii) A minimum approach distance table reflecting the minimum approach distances listed in Table R-6 through Table R-10 shall be printed on a plate of durable non-conductive material. This table shall be mounted so as to be visible to the operator of the boom.

(xix) A non-conductive measuring device shall be readily accessible to assist employees in maintaining the required minimum approach distance.

(4) TOWERS AND STRUCTURES. The following requirements apply to work performed on towers or other structures which support overhead lines.

(i) The employer shall ensure that no employee is under a tower or structure while work is in progress, except where the employer can demonstrate that such a working position is necessary to assist employees working above.

(ii) Tag lines or other similar devices shall be used to maintain control of tower sections being raised or positioned, unless the employer can demonstrate that the use of such devices would create a greater hazard.

(iii) The loadline may not be detached from a member or section until the load is safely secured.

(iv) Except during emergency restoration procedures, work shall be discontinued when adverse weather conditions would make the work hazardous in spite of the work practices required by this section.

NOTE: Thunderstorms in the immediate vicinity, high winds, snow storms, and ice storms are examples of adverse weather conditions that are presumed to make this work too hazardous to perform, except under emergency conditions.

(r) LINE-CLEARANCE TREE TRIMMING OPERATIONS. This paragraph provides additional requirements for line-clearance tree-trimming operations and for equipment used in these operations.

(1) ELECTRICAL HAZARDS. This paragraph does not apply to qualified employees.

(i) Before an employee climbs, enters, or works around any tree, 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.

(ii) There shall be a second line-clearance tree trimmer within normal (that is, unassisted) voice communication under any of the following conditions:

(A) If a line-clearance tree trimmer is to approach more closely than 10 feet (305 cm) any conductor or electric apparatus energized at more than 750 volts or

(B) If branches or limbs being removed are closer to lines energized at more than 750 volts than the distances listed in Table R-6, Table R-9, and Table R-10 or

(C) If roping is necessary to remove branches or limbs from such conductors or apparatus.

(iii) Line clearance tree trimmers shall maintain the minimum approach distances from energized conductors given in Table R-6, Table R-9, and Table R-10.

(iv) Branches that are contacting exposed energized conductors or equipment or that are within the distances specified in Table R-6, Table R-9, and Table R-10 may be removed only through the use of insulating equipment.

NOTE: A tool constructed of a material that the employer can demonstrate has insulating qualities meeting paragraph (j)(1) of this section is considered as insulated under this paragraph if the tool is clean and

dry.

(v) Ladders, platforms, and aerial devices may not be brought closer to an energized part than the distances listed in Table R-6, Table R-9, and Table R-10.

(vi) Line-clearance tree-trimming work may not be performed when adverse weather conditions make the work hazardous in spite of the work practices required by this section. Each employee performing line-clearance tree trimming work in the aftermath of a storm or under similar emergency conditions shall be trained in the special hazards related to this type of work.

NOTE: Thunderstorms in the immediate vicinity, high winds, snow storms, and ice storms are examples of adverse weather conditions that are presumed to make line-clearance tree trimming work too hazardous to perform safely.

(2) BRUSH CHIPPERS. (i) Brush chippers shall be equipped with a locking device in the ignition system.

(ii) Access panels for maintenance and adjustment of the chipper blades and associated drive train shall be in place and secure during operation of the equipment.

(iii) Brush chippers not equipped with a mechanical infeed system shall be equipped with an infeed hopper of length sufficient to prevent employees from contacting the blades or knives of the machine during operation.

(iv) Trailer chippers detached from trucks shall be chocked or otherwise secured.

(v) Each employee in the immediate area of an operating chipper feed table shall wear personal protective equipment as required by Subpart I of this Part.

(3) SPRAYERS AND RELATED EQUIPMENT. (i) 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 Subpart D may be used instead of slip-resistant material.

(ii) 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 Subpart D of this Part.

(4) STUMP CUTTERS. (i) Stump cutters shall be equipped with enclosures or guards to protect employees.

(ii) Each employee in the immediate area of stump grinding operations (including the stump cutter operator) shall wear personal protective equipment as required by Subpart I of this Part.

(5) GASOLINE-ENGINE POWER SAWS. Gasoline-engine power saw operations shall meet the requirements of §1910.266(c)(5) of this Part and the following:

(i) Each power saw weighing more than 15 pounds (6.8 kilograms, service weight) that is used in trees shall be supported by a separate line, except when work is performed from an aerial lift and except during topping or removing operations where no supporting limb will be available.

(ii) Each power saw shall be equipped with a control that will return the saw to idling speed when released.

(iii) Each power saw shall be equipped with a clutch and shall be so adjusted that the clutch will not engage the chain drive at idling speed.

(iv) A power saw shall be started on the ground or where it is otherwise firmly supported. Drop starting of saws over 15 pounds (6.8 kg) is permitted outside of the bucket of an aerial lift only if the area below the lift is clear of personnel.

(v) A power saw engine may be started and operated only when all employees other than the operator are clear of the saw.

(vi) A power saw may not be running when the saw is being carried up into a tree by an employee.

(vii) Power saw engines shall be stopped for all cleaning, refueling, adjustments, and repairs to the saw or motor, except as the manufacturer's servicing procedures require otherwise.

(6) BACKPACK POWER UNITS FOR USE IN PRUNING AND CLEARING. (i) While a backpack power unit is running, no one other than the operator may be within 10 feet (305 cm) of the cutting head of a brush saw.

(ii) A backpack power unit shall be equipped with a quick shutoff switch readily accessible to the operator.

(iii) Backpack power unit engines shall be stopped for all cleaning, refueling, adjustments, and repairs to the saw or motor, except as the manufacturer's servicing procedures require otherwise.

(7) ROPE. (i) Climbing ropes shall be used by employees working aloft in trees. These ropes shall have a minimum diameter of 0.5 inch (1.2 cm) with a minimum breaking strength of 2300 pounds (10.2 kN). Synthetic rope shall have elasticity of not more than 7 percent.

(ii) Rope shall be inspected before each use and, if unsafe (for example because of damage or defect), may not be used.

(iii) Rope shall be stored away from cutting edges and sharp tools. Rope contact with corrosive chemicals, gas, and oil shall be avoided.

(iv) When stored, rope shall be coiled and piled, or shall be suspended, so that air can circulate through the coils.

(v) Rope ends shall be secured to prevent their unraveling.

(vi) Climbing rope may not be spliced to effect repair.

(vii) 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 may not be used near exposed energized lines.

(8) FALL PROTECTION. Each employee shall be tied in with a climbing rope and safety saddle when the employee is working above the ground in a tree, unless he or she is ascending into the tree.

(s) COMMUNICATION FACILITIES - (1) MICROWAVE TRANSMISSION. (i) The employer shall ensure that no employee looks into an open waveguide or antenna that is connected to an energized microwave source.

(ii) If the electromagnetic radiation level within an accessible area associated with microwave communications systems exceeds the radiation protection guide given in §1910.97(a)(2) of this Part, the area shall be posted with the warning symbol described in §1910.97(a)(3) of this Part. The lower half of the warning symbol shall include the following statements or ones that the employer can demonstrate are equivalent:

Radiation in this area may exceed hazard limitations and special precautions are required. Obtain specific instruction before entering.

(iii) When an employee works in an area where the electromagnetic radiation could exceed the radiation protection guide, the employer shall institute measures that ensure that the employee's exposure is not greater than that permitted by that guide. Such measures may include administrative and engineering controls and personal protective equipment.

(2) POWER LINE CARRIER. Power line carrier work, including work on equipment used for coupling carrier current to power line conductors, shall be performed in accordance with the requirements of this section pertaining to work on energized lines.

(t) UNDERGROUND ELECTRICAL INSTALLATIONS. This paragraph provides additional requirements for work on underground electrical installations.

(1) ACCESS. A ladder or other climbing device shall be used to enter and exit a manhole or subsurface vault exceeding 4 feet (122 cm) in depth. No employee may climb into or out of a manhole or vault by stepping on cables or hangers.

(2) LOWERING EQUIPMENT INTO MANHOLES. 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. Before tools or material are lowered 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) ATTENDANTS FOR MANHOLES. (i) While work is being performed in a manhole containing energized electric equipment, an employee with first aid and CPR training meeting paragraph (b)(1) of this section shall be available on the surface in the immediate vicinity to render emergency assistance.

(ii) Occasionally, the employee on the surface may briefly enter a manhole to provide assistance, other than emergency.

NOTE 1: An attendant may also be required under paragraph (e)(7) of this section. One person may serve to fulfill both requirements. However, attendants required under paragraph (e)(7) of this section are not permitted to enter the manhole.

NOTE 2: Employees entering manholes containing unguarded, uninsulated energized lines or parts of electric equipment operating at 50 volts or more are required to be qualified under paragraph (l)(1) of this section.

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

(iv) Reliable communications, through two-way radios or other equivalent means, shall be maintained among all employees involved in the job.

(4) DUCT RODS. If duct rods are used, they shall be installed in the direction presenting the least hazard to employees. An employee shall be stationed at the far end of the duct line being rodged to ensure that the required minimum approach distances are maintained.

(5) MULTIPLE CABLES. When multiple cables are present in a work area, the cable to be worked shall be identified by electrical means, unless its identity is obvious by reason of distinctive appearance or location or by other readily apparent means of identification. Cables other than the one being worked shall be protected from damage.

(6) MOVING CABLES. Energized cables that are to be moved shall be inspected for defects.

(7) DEFECTIVE CABLES. Where a cable in a manhole has one or more abnormalities that could lead to or be an indication of an impending fault, the defective cable shall be deenergized before any employee may work in the manhole, except when service load conditions and a lack of feasible alternatives require that the cable remain energized. In that case, employees may enter the manhole provided they are protected from the possible effects of a failure by shields or other devices that are capable of containing the adverse effects of a fault in the joint.

NOTE: Abnormalities such as oil or compound leaking from cable or joints, broken cable sheaths or joint sleeves, hot localized surface temperatures of cables or joints, or joints that are swollen beyond normal tolerance are presumed to lead to or be an indication of an impending fault.

(8) SHEATH CONTINUITY. When work is performed on buried cable or on cable in manholes, metallic sheath continuity shall be maintained or the cable sheath shall be treated as energized.

(u) SUBSTATIONS. This paragraph provides additional requirements for substations and for work performed in them.

(1) ACCESS AND WORKING SPACE. Sufficient access and working space shall be provided and maintained about electric equipment to permit ready and safe operation and maintenance of such equipment.

NOTE: Guidelines for the dimensions of access and working space about electric equipment in substations are contained in American National Standard - National Electrical Safety Code, ANSI C2-1987. Installations meeting the ANSI provisions comply with paragraph (u)(1) of this section. An installation that does not conform to this ANSI standard will, nonetheless, be considered as complying with paragraph (u)(1) of this section if the employer can demonstrate that the installation provides ready and safe access based on the following evidence:

(1) That the installation conforms to the edition of ANSI C2 that was in effect at the time the installation was made.

(2) That the configuration of the installation enables employees to maintain the minimum approach distances required by paragraph (l)(2) of this section while they are working on exposed, energized parts, and

(3) That the precautions taken when work is performed on the installation provide protection equivalent to the protection that would be provided by access and working space meeting ANSI C2-1987.

(2) DRAW-OUT-TYPE CIRCUIT BREAKERS. When draw-out-type circuit breakers are removed

or inserted, the breaker shall be in the open position. The control circuit shall also be rendered inoperative, if the design of the equipment permits.

(3) SUBSTATION FENCES. Conductive fences around substations shall be grounded. When a substation fence is expanded or a section is removed, fence grounding continuity shall be maintained, and bonding shall be used to prevent electrical discontinuity.

(4) GUARDING OF ROOMS CONTAINING ELECTRIC SUPPLY EQUIPMENT. (i) Rooms and spaces in which electric supply lines or equipment are installed shall meet the requirements of paragraphs (u)(4)(ii) through (u)(4)(v) of this section under the following conditions:

(A) If exposed live parts operating at 50 to 150 volts to ground are located within 8 feet of the ground or other working surface inside the room or space,

(B) If live parts operating at 151 to 600 volts and located within 8 feet of the ground or other working surface inside the room or space are guarded only by location, as permitted under paragraph (u)(5)(i) of this section, or

(C) If live parts operating at more than 600 volts are located within the room or space, unless:

(1) The live parts are enclosed within grounded, metal-enclosed equipment whose only openings are designed so that foreign objects inserted in these openings will be deflected from energized parts, or

(2) The live parts are installed at a height above ground and any other working surface that provides protection at the voltage to which they are energized corresponding to the protection provided by an 8-foot height at 50 volts.

(ii) The rooms and spaces shall be so enclosed within fences, screens, partitions, or walls as to minimize the possibility that unqualified persons will enter.

(iii) Signs warning unqualified persons to keep out shall be displayed at entrances to the rooms and spaces.

(iv) Entrances to rooms and spaces that are not under the observation of an attendant shall be kept locked.

(v) Unqualified persons may not enter the rooms or spaces while the electric supply lines or equipment are energized.

(5) GUARDING OF ENERGIZED PARTS. (i) Guards shall be provided around all live parts operating at more than 150 volts to ground without an insulating covering, unless the location of the live parts gives sufficient horizontal or vertical or a combination of these clearances to minimize the possibility of accidental employee contact.

NOTE: Guidelines for the dimensions of clearance distances about electric equipment in substations are contained in American National Standard - National Electrical Safety Code, ANSI C2-1987. Installations meeting the ANSI provisions comply with paragraph (u)(5)(i) of this section. An installation that does not conform to this ANSI standard will, nonetheless, be considered as complying with paragraph (u)(5)(i) of this section if the employer can demonstrate that the installation provides sufficient clearance based on the following evidence:

(1) That the installation conforms to the edition of ANSI C2 that was in effect at the time the installation was made.

(2) That each employee is isolated from energized parts at the point of closest approach, and

(3) That the precautions taken when work is performed on the installation provide protection equivalent to the protection that would be provided by horizontal and vertical clearances meeting ANSI C2-1987.

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

(iii) When guards are removed from energized equipment, barriers shall be installed 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.

(6) SUBSTATION ENTRY. (I) Upon entering an attended substation, each employee other than those regularly working in the station shall report his or her presence to the employee in charge in order to

receive information on special system conditions affecting employee safety.

(ii) The job briefing required by paragraph (c) of this section shall cover such additional subjects as the location of energized equipment in or adjacent to the work area and the limits of any deenergized work area.

(v) POWER GENERATION. This paragraph provides additional requirements and related work practices for power generating plants.

(1) INTERLOCKS AND OTHER SAFETY DEVICES. (i) Interlocks and other safety devices shall be maintained in a safe, operable condition.

(ii) No interlock or other safety device may 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 may not be changed while the generator is energized if a ground condition exists.

(3) ACCESS AND WORKING SPACE. Sufficient access and working space shall be provided and maintained about electric equipment to permit ready and safe operation and maintenance of such equipment.

NOTE: Guidelines for the dimensions of access and working space about electric equipment in generating stations are contained in American National Standard - National Electrical Safety Code, ANSI C2-1987. Installations meeting the ANSI provisions comply with paragraph (v)(3) of this section. An installation that does not conform to this ANSI standard will, nonetheless, be considered as complying with paragraph (v)(3) of this section if the employer can demonstrate that the installation provides ready and safe access based on the following evidence:

(1) That the installation conforms to the edition of ANSI C2 that was in effect at the time the installation was made.

(2) That the configuration of the installation enables employees to maintain the minimum approach distances required by paragraph (l)(2) of this section while they are working on exposed, energized parts, and

(3) That the precautions taken when work is performed on the installation provide protection equivalent to the protection that would be provided by access and working space meeting ANSI C2-1987.

(4) GUARDING OF ROOMS CONTAINING ELECTRIC SUPPLY EQUIPMENT. (i) Rooms and spaces in which electric supply lines or equipment are installed shall meet the requirements of paragraphs (v)(4)(ii) through (v)(4)(v) of this section under the following conditions:

(A) If exposed live parts operating at 50 to 150 volts to ground are located within 8 feet of the ground or other working surface inside the room or space,

(B) If live parts operating at 151 to 600 volts and located within 8 feet of the ground or other working surface inside the room or space are guarded only by location, as permitted under paragraph (v)(5)(i) of this section, or

(C) If live parts operating at more than 600 volts are located within the room or space, unless:

(1) The live parts are enclosed within grounded metal-enclosed equipment whose only openings are designed so that foreign objects inserted in these openings will be deflected from energized parts, or

(2) The live parts are installed at a height above ground and any other working surface that provides protection at the voltage to which they are energized corresponding to the protection provided by an 8-foot height at 50 volts.

(ii) The rooms and spaces shall be so enclosed within fences, screens, partitions, or walls as to minimize the possibility that unqualified persons will enter.

(iii) Signs warning unqualified persons to keep out shall be displayed at entrances to the rooms and spaces.

(iv) Entrances to rooms and spaces that are not under the observation of an attendant shall be kept locked.

(v) Unqualified persons may not enter the rooms or spaces while the electric supply lines or equipment are energized.

(5) **GUARDING OF ENERGIZED PARTS.** (i) Guards shall be provided around all live parts operating at more than 150 volts to ground without an insulating covering, unless the location of the live parts gives sufficient horizontal or vertical or a combination of these clearances to minimize the possibility of accidental employee contact.

NOTE: Guidelines for the dimensions of clearance distances about electric equipment in generating stations are contained in American National Standard - National Electrical Safety Code, ANSI C2-1987. Installations meeting the ANSI provisions comply with paragraph (v)(5)(i) of this section. An installation that does not conform to this ANSI standard will, nonetheless, be considered as complying with paragraph (v)(5)(i) of this section if the employer can demonstrate that the installation provides sufficient clearance based on the following evidence:

(1) That the installation conforms to the edition of ANSI C2 that was in effect at the time the installation was made,

(2) That each employee is isolated from energized parts at the point of closest approach, and

(3) That the precautions taken when work is performed on the installation provide protection equivalent to the protection that would be provided by horizontal and vertical clearances meeting ANTI C2-1987.

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

(iii) When guards are removed from energized equipment, barriers shall be installed 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.

(6) **WATER OR STEAM SPACES.** The following requirements apply to work in water and steam spaces associated with boilers:

(i) 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.

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

(7) **CHEMICAL CLEANING OF BOILERS AND PRESSURE VESSELS.** The following requirements apply to chemical cleaning of boilers and pressure vessels:

(i) 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.

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

(iii) There shall be ready access to water or showers for emergency use.

NOTE: See §1910.141 of this Part for requirements that apply to the water supply and to washing facilities.

(iv) Employees in restricted areas shall wear protective equipment meeting the requirements of Subpart I of this Part and including, but not limited to, protective clothing, boots, goggles, and gloves.

(8) **CHLORINE SYSTEMS.** (i) Chlorine system enclosures shall be posted with signs restricting entry and warning of the hazard to health and the hazards of fire and explosion.

NOTE: See Subpart Z of this Part for requirements necessary to protect the health of employees from the effects of chlorine.

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

(iii) 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.

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

(v) 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.

(9) BOILERS. (i) 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.

(ii) 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.

(10) TURBINE GENERATORS. (i) 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.

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

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

(11) COAL AND ASH HANDLING. (i) Only designated persons may operate railroad equipment.

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

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

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

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

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

(vii) 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 paragraphs (v)(11)(viii) through (v)(11)(xii) of this section.

(viii) Employees may not ride a coal- or ash-handling conveyor belt at any time. Employees may 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 paragraph (d) of this section.

(ix) What could cause injury when started may 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.

(x) 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.

EXCEPTION: 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 must keep clear. These warning signs shall be provided along the conveyor at areas not guarded by position or location.

(xi) 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.

(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 may not depend on the stopping of any other equipment.

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

(xii) 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: Locations that are hazardous because of the presence of combustible dust are classified as Class II hazardous locations. See §1910.307 of this Part.

(xiii) An employee may 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.

(xiv) 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.

(12) 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.

(w) SPECIAL CONDITIONS - (1) CAPACITORS. The following additional requirements apply to work on capacitors and on lines connected to capacitors.

NOTE: See paragraphs (m) and (n) of this section for requirements pertaining to the deenergizing and grounding of capacitors installations.

(i) Before employees work on capacitors, the capacitors shall be disconnected from energized sources and, after a wait of at least 5 minutes from the time of disconnection, short-circuited.

(ii) Before the units are handled, each unit in series-parallel capacitor banks shall be short-circuited between all terminals and the capacitor case or its rack. If the cases of capacitors are on ungrounded substation racks, the racks shall be bonded to ground.

(iii) Any line to which capacitors are connected shall be short-circuited before it is considered deenergized.

(2) CURRENT TRANSFORMER SECONDARIES. The secondary of a current transformer may not be opened while the transformer is energized. If the primary of the current transformer cannot be deenergized before work is performed on an instrument, a relay, or other section of a current transformer secondary circuit, the circuit shall be bridged so that the current transformer secondary will not be opened.

(3) SERIES STREETLIGHTING. (i) If the open-circuit voltage exceeds 600 volts, the series streetlighting circuit shall be worked in accordance with paragraph (q) or (t) of this section, as appropriate.

(ii) A series loop may only be opened after the streetlighting transformer has been deenergized and isolated from the source of supply or after the loop is bridged to avoid an open-circuit condition.

(4) ILLUMINATION. Sufficient illumination shall be provided to enable the employee to perform the work safely.

(5) PROTECTION AGAINST DROWNING. (i) Whenever an employee may be pulled or pushed or may fall into water where the danger of drowning exists, the employee shall be provided with and shall use U.S. Coast Guard approved personal flotation devices.

(ii) Each personal flotation device shall be maintained in safe condition and shall be inspected 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.

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

(6) EMPLOYEE PROTECTION IN PUBLIC WORK AREAS. (i) Traffic control signs and traffic control devices used for the protection of employees shall meet the requirements of §1926.200(g)(2) of this Chapter.

(ii) Before work is begun in the vicinity of vehicular or pedestrian traffic that may endanger employees, warning signs or flags and other traffic control devices shall be placed in conspicuous locations to alert and channel approaching traffic.

(iii) Where additional employee protection is necessary, barricades shall be used.

(iv) Excavated areas shall be protected with barricades.

(v) At night, warning lights shall be prominently displayed.

(7) BACKFEED. If there is a possibility of voltage backfeed from sources of cogeneration or from the secondary system (for example, backfeed from more than one energized phase feeding a common load), the requirements of paragraph (l) of this section apply if the lines or equipment are to be worked as energized, and the requirements of paragraphs (m) and (n) of this section apply if the lines or equipment are to be worked as deenergized.

(8) LASERS. Laser equipment shall be installed, adjusted, and operated in accordance with §1926.54 of this Chapter.

(9) HYDRAULIC FLUIDS. Hydraulic fluids used for the insulated sections of equipment shall provide insulation for the voltage involved.

(x) DEFINITIONS.

AFFECTED EMPLOYEE. An employee whose job requires him or her to operate or use a machine or equipment on which servicing or maintenance is being performed under lockout or tagout, or whose job requires him or her to work in an area in which such servicing or maintenance is being performed.

ATTENDANT. An employee assigned to remain immediately outside the entrance to an enclosed or other space to render assistance as needed to employees inside the space.

AUTHORIZED EMPLOYEE. An employee who locks out or tags out machines or equipment in order to perform servicing or maintenance on that machine or equipment. An affected employee becomes an authorized employee when that employee's duties include performing servicing or maintenance covered under this section.

AUTOMATIC CIRCUIT RECLOSER. A self-controlled device for interrupting and reclosing an alternating current circuit with a predetermined sequence of opening and reclosing followed by resetting, hold-closed, or lockout operation.

BARRICADE. A physical obstruction such as tapes, cones, or A-frame type wood or metal structures intended to provide a warning about and to limit access to a hazardous area.

BARRIER. A physical obstruction which is intended to prevent contact with energized lines or equipment or to prevent unauthorized access to a work area.

BOND. The electrical interconnection of conductive parts designed to maintain a common electrical potential.

BUS. A conductor or a group of conductors that serve as a common connection for two or more circuits.

BUSHING. An insulating structure, including a through conductor or providing a passageway for such a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purposes of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

CABLE. A conductor with insulation, or a stranded conductor with or without insulation and other coverings (single-conductor cable), or a combination of conductors insulated from one another (multiple-conductor cable).

CABLE SHEATH. A conductive protective covering applied to cables.

NOTE: A cable sheath may consist of multiple layers of which one or more is conductive.

CIRCUIT. A conductor or system of conductors through which an electric current is intended to flow.

CLEARANCE (BETWEEN OBJECTS). The clear distance between two objects measured surface to surface.

CLEARANCE (FOR WORK). Authorization to perform specified work or permission to enter a restricted area.

COMMUNICATION LINES. (See LINES, COMMUNICATION.)

CONDUCTOR. A material, usually in the form of a wire, cable, or bus bar, used for carrying an electric current.

COVERED CONDUCTOR. A conductor covered with a dielectric having no rated insulating strength or having a rated insulating strength less than the voltage of the circuit in which the conductor is used.

CURRENT-CARRYING PART. A conducting part intended to be connected in an electric circuit to a source of voltage. Non-current-carrying parts are those not intended to be so connected.

DEENERGIZED. Free from any electrical connection to a source of potential difference and from electric charge; not having a potential different from that on the earth.

NOTE: The term is used only with reference to current-carrying parts, which are sometimes energized (alive).

DESIGNATED EMPLOYEE (DESIGNATED PERSON). An employee (or person) who is designated by the employer to perform specific duties under the terms of this section and who is knowledgeable in the construction and operation of the equipment and the hazards involved.

ELECTRIC LINE TRUCK. A truck used to transport personnel, tools, and material for electric supply line work.

ELECTRIC SUPPLY EQUIPMENT. Equipment that produces, modifies, regulates, controls, or safeguards a supply of electric energy.

ELECTRIC SUPPLY LINES. (See LINES, ELECTRIC SUPPLY.)

ELECTRIC UTILITY. An organization responsible for the installation, operation, or maintenance of an electric supply system.

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 that may contain a hazardous atmosphere under abnormal conditions.

NOTE: Spaces that are enclosed but not designed for employee entry under normal operating conditions are not considered to be enclosed spaces for the purposes of this section. Similarly, spaces that are enclosed and that are expected to contain a hazardous atmosphere are not considered to be enclosed spaces for the purposes of this section. Such spaces meet the definition of permit spaces in §1910.146 of this Part, and entry into them must be performed in accordance with that standard.

ENERGIZED (ALIVE, LIVE). Electrically connected to a source of potential difference, or electrically charged so as to have a potential significantly different from that of earth in the vicinity.

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 personnel.

EQUIPMENT (ELECTRIC). A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as part of or in connection with an electrical installation.

EXPOSED. Not isolated or guarded.

GROUND. A conducting connection, whether intentional or accidental, between an electric circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

GROUNDING. Connected to earth or to some conducting body that serves in place of the earth.

GUARDED. Covered, fenced, enclosed, or otherwise protected, by means of suitable covers or casings, barrier rails, or screens, mats, or platforms, designed to minimize the possibility, under normal conditions, of dangerous approach or accidental contact by persons or objects.

NOTE: Wires which are insulated, but not otherwise protected, are not considered as guarded.

HAZARDOUS ATMOSPHERE means an atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue (that is, escape unaided from an enclosed space), injury, or acute illness from one or more of the following causes:

- (1) Flammable gas, vapor, or mist in excess of 10 percent of its lower flammable limit (LFL);
- (2) Airborne combustible dust at a concentration that meets or exceeds its LFL;

NOTE: This concentration may be approximated as a condition in which the dust obscures vision at a distance of 5 feet (1.52 m) or less.

- (3) Atmospheric oxygen concentration below 19.5 percent or above 23.5 percent;
- (4) Atmospheric concentration of any substance for which a dose or a permissible exposure limit is published in Subpart G, OCCUPATIONAL HEALTH AND ENVIRONMENTAL CONTROL, or in Subpart Z, TOXIC AND HAZARDOUS SUBSTANCES, of this Part and which could result in employee exposure in excess of its dose or permissible exposure limit;

NOTE: An atmospheric concentration of any substance that is not capable of causing death, incapacitation, impairment of ability to self-rescue, injury, or acute illness due to its health effects is not covered by this provision.

- (5) Any other atmospheric condition that is immediately dangerous to life or health.

NOTE: For air contaminants for which OSHA has not determined a dose or permissible exposure limit, other sources of information, such as Material Safety Data Sheets that comply with the Hazard Communication Standard, §1910.1200 of this Part, published information, and internal documents can provide guidance in establishing acceptable atmospheric conditions.

HIGH-POWER TESTS. Tests in which fault currents, load currents, magnetizing currents, and line-dropping currents are used to test equipment, either at the equipment's rated voltage or at lower voltages.

HIGH-VOLTAGE TESTS. Tests in which voltages of approximately 1000 volts are used as a practical minimum and in which the voltage source has sufficient energy to cause injury.

HIGH WIND. A wind of such velocity that the following hazards would be present:

- (1) An employee would be exposed to being blown from elevated locations, or
- (2) An employee or material handling equipment could lose control of material being handled, or
- (3) An employee would be exposed to other hazards not controlled by the standard involved.

NOTE: Winds exceeding 40 miles per hour (64.4 kilometers per hour), or 30 miles per hour (48.3 kilometers per hour) if material handling is involved, are normally considered as meeting this criteria unless precautions are taken to protect employees from the hazardous effects of the wind.

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH (IDLH) means any condition that poses an immediate or delayed threat to life or that would cause irreversible adverse health effects or that would interfere with an individual's ability to escape unaided from a permit space.

NOTE: Some materials - hydrogen fluoride gas and cadmium vapor, for example - may produce immediate transient effects that, even if severe, may pass without medical attention, but are followed by sudden, possibly fatal collapse 12-72 hours after exposure. The victim "feels normal" from recovery from transient effects until collapse. Such materials in hazardous quantities are considered to be "immediately" dangerous to life or health.

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

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

INSULATION (CABLE). That which is relied upon to insulate the conductor from other conductors or conducting parts or from ground.

LINE-CLEARANCE TREE TRIMMER. An employee who, through related training or on-the-job experience or both, is familiar with the special techniques and hazards involved in line-clearance tree trimming.

NOTE 1: An employee who is regularly assigned to a line-clearance tree-trimming crew and who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of a line-clearance tree trimmer is considered to be a line-clearance tree trimmer for the performance of those duties.

NOTE 2: A line-clearance tree trimmer is not considered to be a "qualified employee" under this section unless he or she has the training required for a qualified employee under paragraph (a)(2)(ii) of this section. However, under the electrical safety-related work practices standard in Subpart S of this part, a line-clearance tree trimmer is considered to be a "qualified employee". Tree trimming performed by such "qualified employees" is not subject to the electrical safety-related work practice requirements contained in §§1910.331 through 1910.335 of this Part. (See also the note following §1910.332(b)(3) of this Part for information regarding the training an employee must have to be considered a qualified employee under §§1910.331 through 1910.335 of this part.)

LINE-CLEARANCE TREE TRIMMING. The pruning, trimming, repairing, maintaining, removing, or clearing of trees or the cutting of brush that is within 10 feet (305 cm) of electric supply lines and equipment.

LINES. (1) COMMUNICATION LINES. The conductors and their supporting or containing structures which are used for public or private signal or communication service, and which operate at potentials not exceeding 400 volts to ground or 750 volts between any two points of the circuit, and the transmitted power of which does not exceed 150 watts. If the lines are operating at less than 150 volts, no limit is placed on the transmitted power of the system. Under certain conditions, communication cables may include communication circuits exceeding these limitations where such circuits are also used to supply power solely to communication equipment.

NOTE: Telephone, telegraph, railroad signal, data, clock, fire, police alarm, cable television, and other systems conforming to this definition are included. Lines used for signaling purposes, but not included under this definition, are considered as electric supply lines of the same voltage.

(2) ELECTRIC SUPPLY LINES. Conductors used to transmit electric energy and their necessary supporting or containing structures. Signal lines of more than 400 volts are always supply lines within this section, and those of less than 400 volts are considered as supply lines, if so run and operated throughout.

MANHOLE. A subsurface enclosure which personnel may enter and which is used for the purpose of installing, operating, and maintaining submersible equipment or cable.

MANHOLE STEPS. A series of steps individually attached to or set into the walls of a manhole structure.

MINIMUM APPROACH DISTANCE. The closest distance an employee is permitted to approach an energized or a grounded object.

QUALIFIED EMPLOYEE (QUALIFIED PERSON). One knowledgeable in the construction and operation of the electric power generation, transmission, and distribution equipment involved, along with the associated hazards.

QUALIFIED EMPLOYEE (QUALIFIED PERSON). One knowledgeable in the construction and operation of the electric power generation, transmission, and distribution equipment involved, along with the associated hazards.

NOTE 1: An employee must have the training required by paragraph (a)(2)(ii) of this section in order to be considered a qualified employee.

NOTE 2: Except under paragraph (g)(2)(v) of this section, an employee who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties.

STEP BOLT. A bolt or rung attached at intervals along a structural member and used for foot placement during climbing or standing.

SWITCH. A device for opening and closing or for changing the connection of a circuit. In this section, a switch is understood to be manually operable, unless otherwise stated.

SYSTEM OPERATOR. A qualified person designated to operate the system or its parts.

VAULT. An enclosure, above or below ground, which personnel may enter and which is used for the purpose of installing, operating, or maintaining equipment or cable.

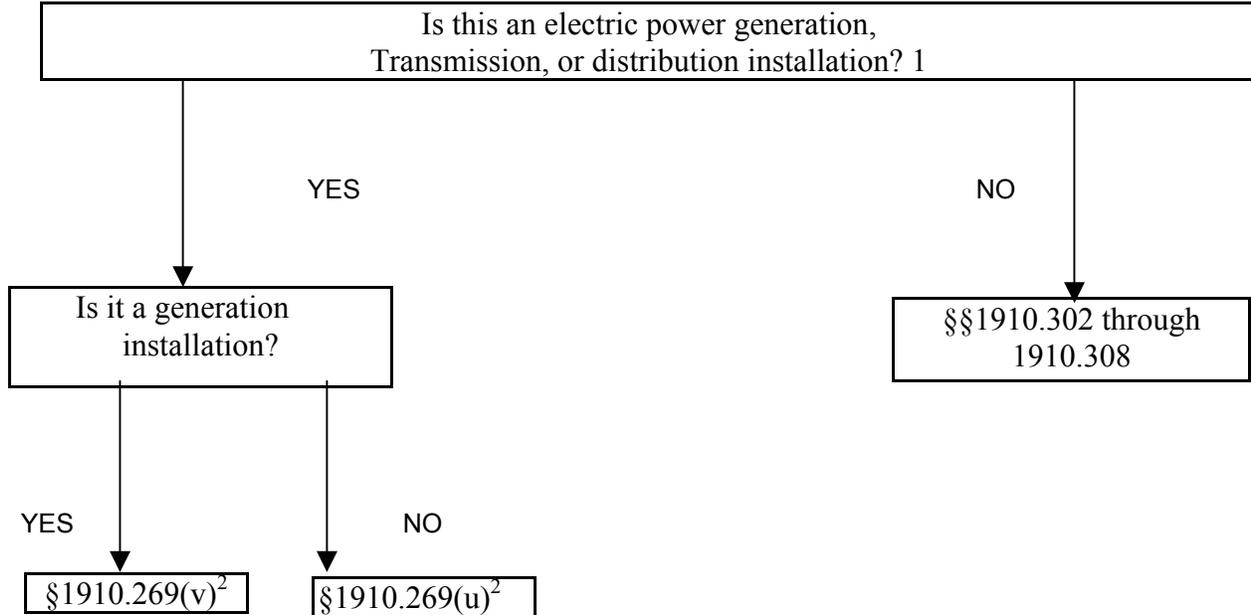
VENTED VAULT. A vault that has provision for air changes using exhaust flue stacks and low level air intakes operating on differentials of pressure and temperature providing for airflow which precludes a hazardous atmosphere from developing.

VOLTAGE. The effective (rms) potential difference between any two conductors or between a conductor and ground. Voltages are expressed in nominal values unless otherwise indicated. The nominal voltage of a system or circuit is the value assigned to a system or circuit of a given voltage class for the purpose of convenient designation. The operating voltage of the system may vary above or below this value.

APPENDIX A TO §1910.269 - FLOW CHARTS

This appendix presents information, in the form of flow charts, that illustrates the scope and application of §1910.269. This appendix addresses the interface between §1910.269 and Subpart S of this Part (ELECTRICAL), between §1910.269 and §1910.146 of this Part (PERMIT-REQUIRED CONFINED SPACES), and between §1910.269 and §1910.147 of this Part (THE CONTROL OF HAZARDOUS ENERGY (LOCKOUT/TAGOUT)). These flow charts provide guidance for employers trying to implement the requirements of §1910.269 in combination with other General Industry Standards contained in Part 1910.

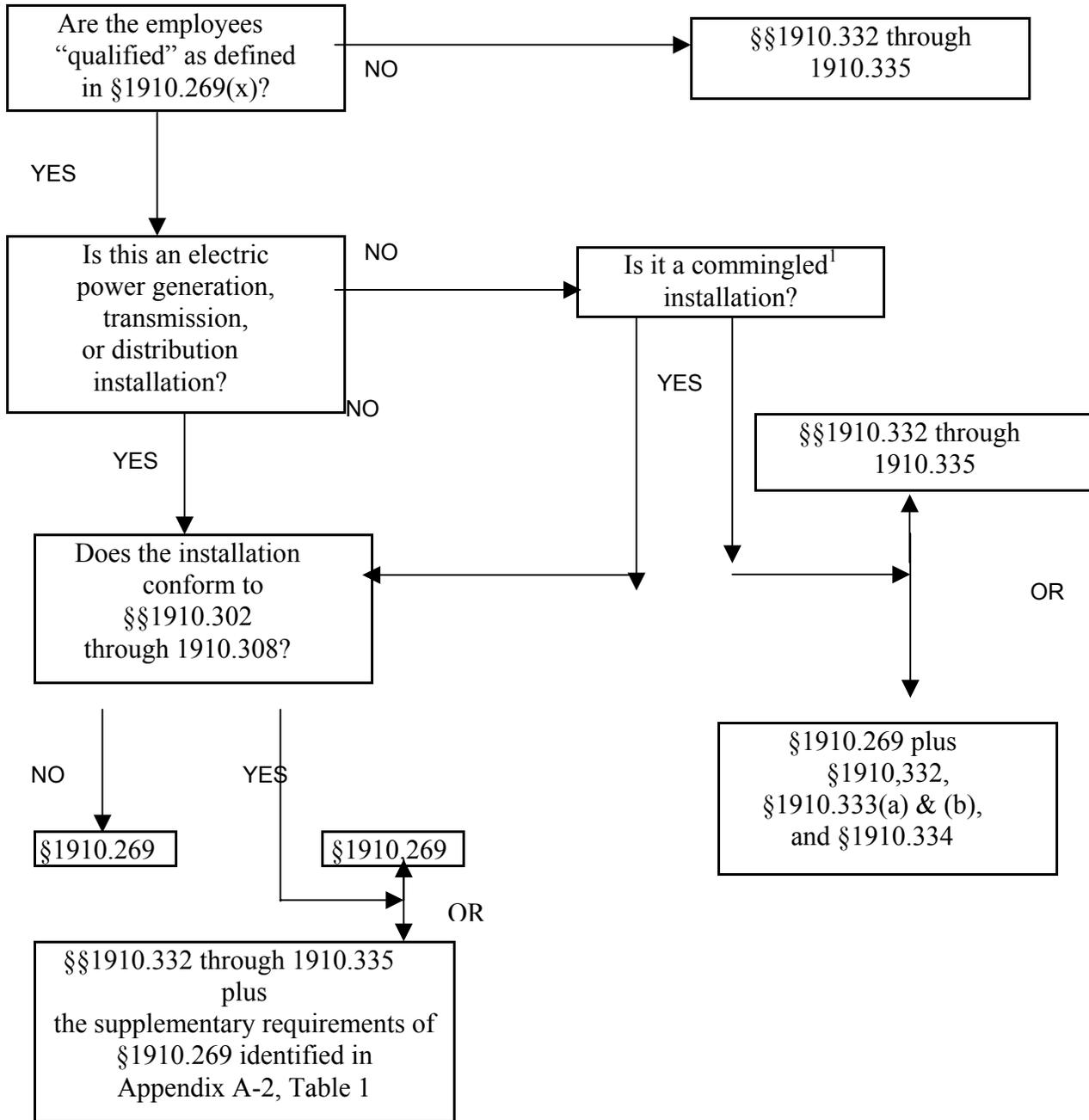
Appendix A-1 to §1910.269 - Application of §1910.269 and Subpart S of this Part to Electrical Installations.



¹Electrical installation design requirements only. See Appendix A2 of this section for electrical safety-related work practices. Supplementary electric generating equipment that is used to supply a workplace for emergency, standby, or similar purposes only is not considered to be an electric power generation installation.

²See Table 1 of Appendix A-2 of this section for requirements that can be met through compliance with Subpart S.

Appendix A-2 to §1910.269--Application of §1910.269 and Subpart S of this Part to Electrical Safety-Related Work Practices.



¹Commingled to the extent that the electric power generation, transmission, or distribution installation poses the greater hazard.

TABLE 1. ELECTRICAL SAFETY-RELATED WORK PRACTICES IN §1910.269

Compliance with subpart S is considered as compliance with §1910.269¹

(d) electric shock hazards only
(h)(3)
(i)(2)
(k)
(l)(l) through (l)(4), (l)(6)(i), and (l)(8) thru (l)(10)
(m)
(p)(4)
(s)(2)
(u)(l) and (u)(3) thru (u)(5)
(v)(3) through (v)(5)
(w)(l) and (w)(7)

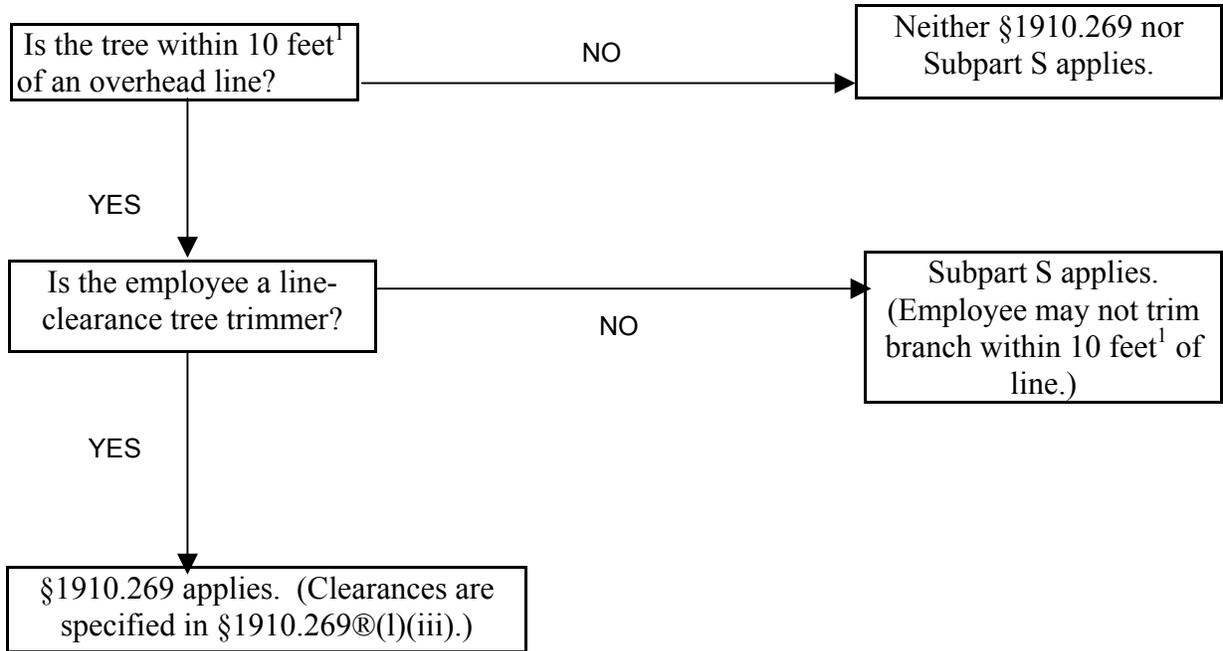
Paragraphs that apply regardless of compliance with subpart S

(a)(2)² and (a)(3)².
(b)².
(c)².
(d), other than electric shock hazards.
(e).
(f).
(g).
(h)(l) and (h)(2).
(i)(3)² and (i)(4)².
(j)².
(l)(5)², (l)(6)(ii)², (l)(6)(iii)², and (l)(7)².
(n)².
(o)².
(p)(1) through (p)(3).
(q)².
(r)².
(s)(1).
(t)².
(u)(2)² and (u)(6)².
(v)(1), (v)(2)², and (v)(6) through (v)(12).
(w)(2) through (w)(6)², (w)(8), and (w)(9)².

¹If the electrical installation meets the requirements of §§1910.303 through 1910.308 of this Part, then the electrical installation and any associated electrical safety-related work practices conforming to §§1910.332 through 1910.335 of this Part are considered to comply with these provisions of §1910.269 of this Part.

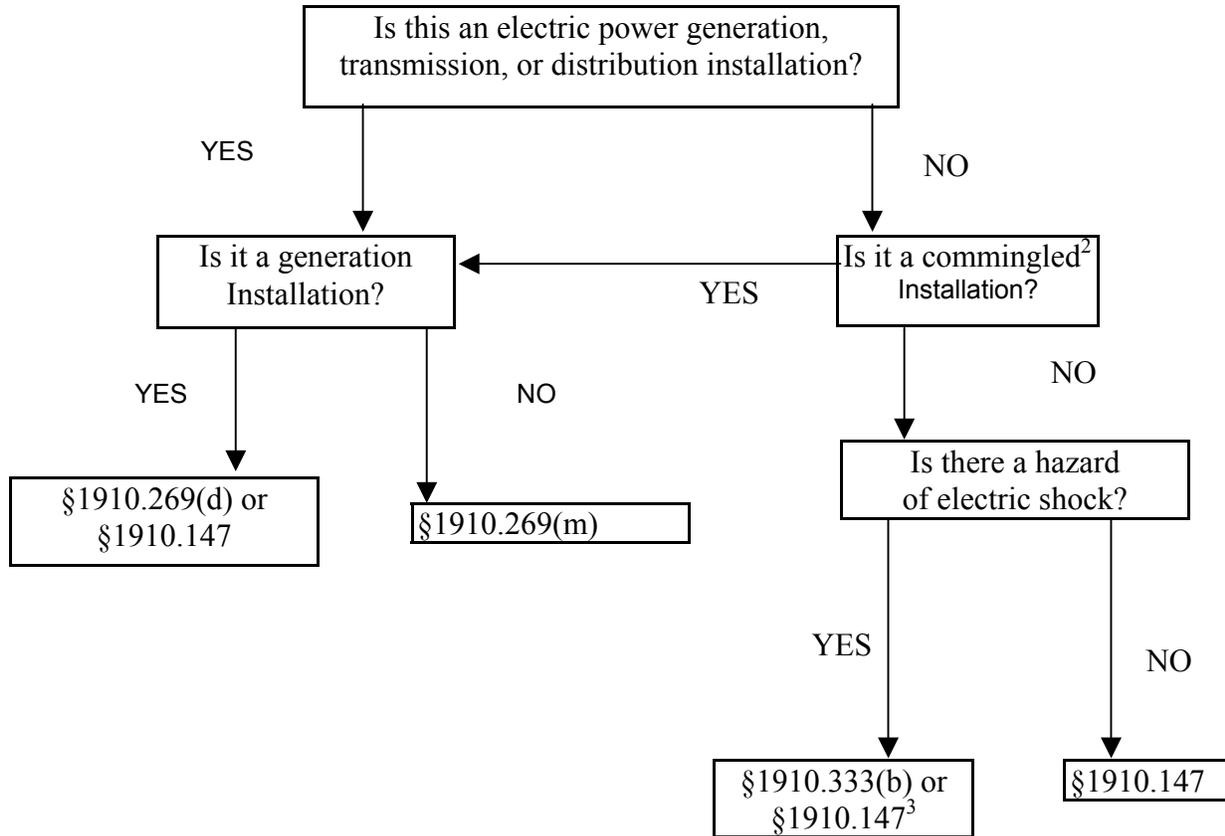
²These provisions include electrical safety requirements that must be met regardless of compliance with Subpart S of this Part.

Appendix A-3 to §1910.269--Application of §1910.269 and Subpart S of This Part to Tree-Trimming Operations.



¹10 feet plus 4 inches for every 10 kilovolts over 50 kilovolts.

Appendix A-4 to §1910.269--Application of §§1910.147, 1910.269 and 1910.333 to Hazardous Energy Control Procedures (Lockout/Tagout).

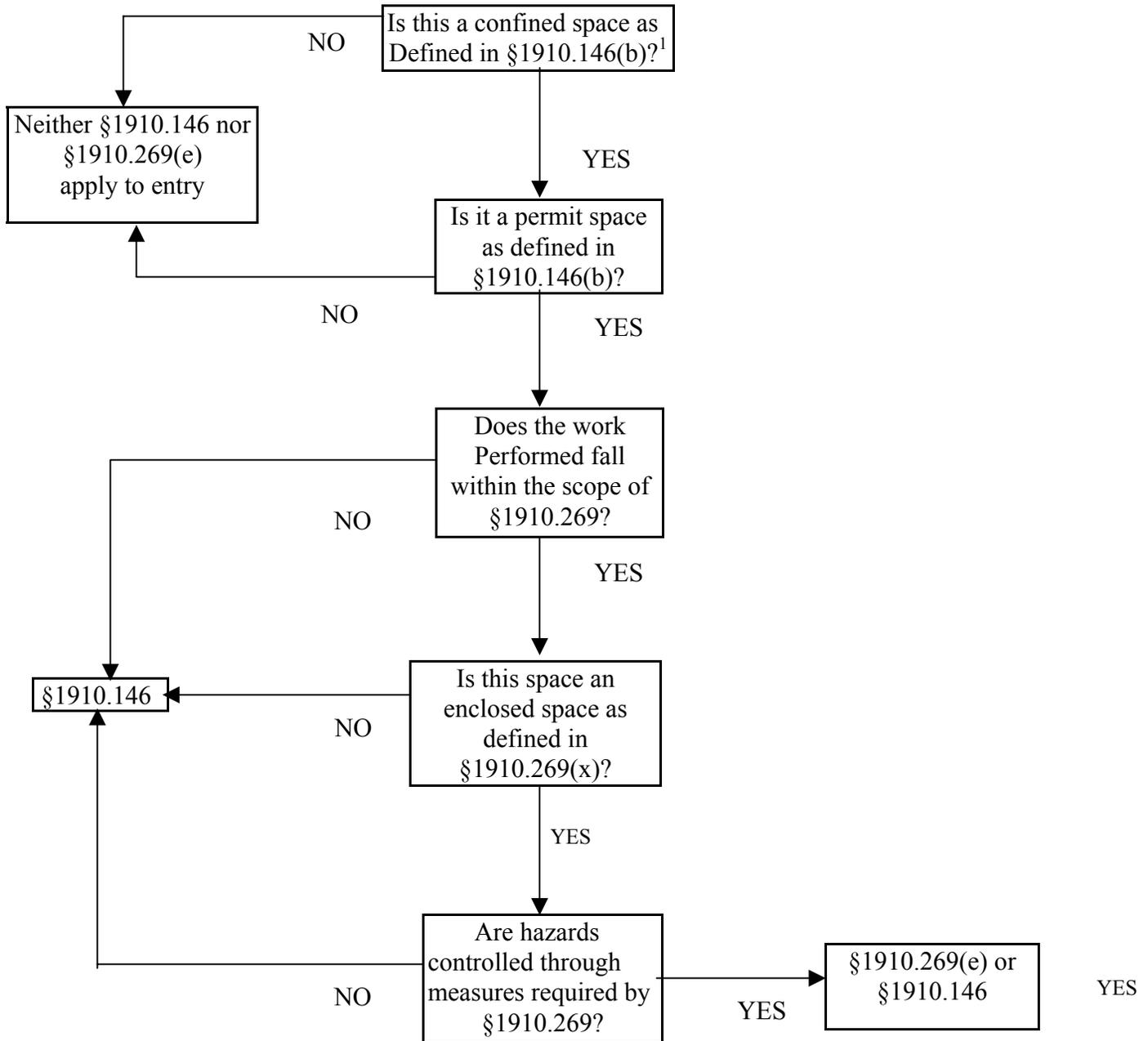


¹If the installation conforms to §§1910.303 through 1910.308, the lockout and tagging procedures of 1910.333(b) may be followed for electric shock hazards.

²Commingled to the extent that the electric power generation, transmission, or distribution installation poses the greater hazard.

³§1910.333(b)(2)(iii)(D) and (b)(2)(iv)(B) still apply.

Appendix A-5 to §1910.269 -- Application of §§1910.146 and 1910.269 to Permit-Required Confined Spaces.



¹See §1910.146(c) for general non-entry requirements that apply to all confined spaces.

APPENDIX B TO §1910.269 - WORKING ON EXPOSED ENERGIZED PARTS

I. INTRODUCTION

Electric transmission and distribution line installations have been designed to meet National Electrical Safety Code (NESC), ANSI C2, requirements and to provide the level of line outage performance required by system reliability criteria. Transmission and distribution lines are also designed to withstand the maximum overvoltages expected to be impressed on the system. Such overvoltages can be caused by such conditions as switching surges, faults, or lightning. Insulator design and lengths and the clearances to structural parts (which, for low voltage through extra-high voltage, or EHV, facilities, are generally based on the performance of the line as a result of contamination of the insulation or during storms) have, over the years, come closer to the minimum approach distances used by workers (which are generally based on non-storm conditions). Thus, as minimum approach (working) distances and structural distances (clearances) converge, it is increasingly important that basic considerations for establishing safe approach distances for performing work be understood by the designers and the operating and maintenance personnel involved.

The information in this Appendix will assist employers in complying with the minimum approach distance requirements contained in paragraphs (1)(2) and (q)(3) of this section. The technical criteria and methodology presented herein is mandatory for employers using reduced minimum approach distances as permitted in Table R-7 and Table R-8. This Appendix is intended to provide essential background information and technical criteria for the development or modification, if possible, of the safe minimum approach distances for electric transmission and distribution live-line work. The development of these safe distances must be undertaken by persons knowledgeable in the techniques discussed in this appendix and competent in the field of electric transmission and distribution system design.

II. GENERAL

A. DEFINITIONS

The following definitions from §1910.269(x) relate to work on or near transmission and distribution lines and equipment and the electrical hazards they present.

EXPOSED. Not isolated or guarded.

GUARDED. Covered, fenced, enclosed, or otherwise protected, by means of suitable covers or casings, barrier rails or screens, mats, or platforms, designed to minimize the possibility, under normal conditions, of dangerous approach or accidental contact by persons or objects.

NOTE: Wires which are insulated, but not otherwise protected, are not considered as guarded.

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

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

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 must avoid contact with the exposed parts, and the protective equipment used (such as rubber insulating gloves) must provide insulation for the voltages involved.

C. EXPOSED ENERGIZED PARTS OVER 300 VOLTS AC

Table R-6, Table R-7 and Table R-8 of §1910.269 provide safe approach and working distances in the vicinity of energized electric apparatus so that work can be done safely without risk of electrical flashover.

The working distances must withstand the maximum transient overvoltage that can reach the work site under the working conditions and practices in use. Normal system design may provide or include a means to control transient overvoltages, or temporary devices may be employed to achieve the same result. The use of technically correct practices or procedures to control overvoltages (for example, portable gaps or preventing the automatic control from initiating breaker reclosing) enables line design and operation to be based on reduced transient overvoltage values. Technical information for U.S. electrical systems indicates that current design provides for the following maximum transient overvoltage values (usually produced by switching surges): 362 kV and less - 3.0 per unit; 552 kV - 2.4 per unit; 800 kV - 2.0 per unit.

Additional discussion of maximum transient overvoltages can be found in paragraph IV.A.2, later in this Appendix.

III. DETERMINATION OF THE ELECTRICAL COMPONENT OF MINIMUM APPROACH DISTANCES

A. VOLTAGES OF 1.1 kV to 72.5 kV

For voltages of 1.1 kV to 72.5 kV, the electrical component of minimum approach distances is based on American National Standards Institute (ANSI)/American Institute of Electrical Engineers (AIEE) Standard No. 4, March 1943, Tables III and IV. (AIEE is the predecessor technical society to the Institute of Electrical and Electronic Engineers (IEEE).) These distances are calculated by the following formula:

EQUATION (1) - FOR VOLTAGES OF 1.1 kV TO 72.5 kV

$$D = \left(\frac{V_{\max} \times \text{pu}}{124} \right)^{1.63}$$

Where: D = Electrical component of the minimum approach distance in air in feet
 V_{\max} = Maximum rated line-to-ground rms voltage in kV
 pu = Maximum transient overvoltage factor in per unit

Source: AIEE Standard No. 4, 1943.

This formula has been used to generate Table 1.

TABLE 1. - AC ENERGIZED LINE-WORK PHASE-TO-GROUND ELECTRICAL COMPONENT OF THE MINIMUM APPROACH DISTANCE - 1.1 TO 72.5 kV

Maximum anticipated per-unit transient overvoltage	Phase to phase voltage			
	15,000	36,000	46,000	72,500
3.0	0.08	0.33	0.49	1.03

NOTE: The distances given (in feet) are for air as the insulating medium and provide no additional clearance for inadvertent movement.

B. VOLTAGES OF 72.6 kV TO 800 kV

For voltages of 72.6 kV to 800 kV, the electrical component of minimum approach distances is based on ANSI/IEEE Standard 516-1987, "IEEE Guide for Maintenance Methods on Energized Power Lines." This standard gives the electrical component of the minimum approach distance based on power frequency rod-gap data, supplemented with transient overvoltage information and a saturation factor for high voltages. The distances listed in ANSI/IEEE Standard 516 have been calculated according to the following formula:

EQUATION (2) - FOR VOLTAGES OF 72.6 kV TO 800 kV

$$D = (C + a) puV_{\max}$$

Where: D = Electrical component of the minimum approach distance in air in feet
 C = 0.01 to take care of correction factors associated with the variation of gap sparkover with voltage
 a = A factor relating to the saturation of air at voltages of 345 kV or higher
 pu = Maximum anticipated transient overvoltage, in per unit (p.u.)
 V_{max} = Maximum rms system line-to-ground 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)

Source: Formula developed from ANSI/IEEE Standard No. 516, 1987.

This formula is used to calculate the electrical component of the minimum approach distances in air and is used in the development of Table 2 and Table 3.

TABLE 2. - AC ENERGIZED LINE-WORK PHASE-TO-GROUND ELECTRICAL COMPONENT OF THE MINIMUM APPROACH DISTANCE - 121 TO 242 kV

Maximum anticipated per-unit transient overvoltage	Phase to phase voltage			
	121,000	145,000	169,000	242,000
2.0	1.40	1.70	2.00	2.80
2.1	1.47	1.79	2.10	2.94
2.2	1.54	1.87	2.20	3.08
2.3	1.61	1.96	2.30	3.22
2.4	1.68	2.04	2.40	3.35
2.5	1.75	2.13	2.50	3.50
2.6	1.82	2.21	2.60	3.64
2.7	1.89	2.30	2.70	3.76
2.8	1.96	2.38	2.80	3.92
2.9	2.03	2.47	2.90	4.05
3.0	2.10	2.55	3.00	4.29

NOTE: The distances given (in feet) are for air as the insulating medium and provide no additional clearance for inadvertent movement.

TABLE 3. - AC ENERGIZED LINE-WORK PHASE-TO-GROUND ELECTRICAL COMPONENT OF THE

MINIMUM APPROACH DISTANCE - 362 TO 800 kV

Maximum anticipated per-unit transient overvoltage	Phase to phase voltage		
	362,000	552,000	800,000
1.5		4.97	8.66
1.6		5.46	9.60
1.7		5.98	10.60
1.8		6.51	11.64
1.9		7.08	12.73
2.0	4.20	7.68	13.86
2.1	4.41	8.27	
2.2	4.70	8.87	
2.3	5.01	9.49	
2.4	5.34	10.21	
2.5	5.67		
2.6	6.01		
2.7	6.36		
2.8	6.73		
2.9	7.10		
3.0	7.48		

NOTE: The distances given (in feet) are for air as the insulating medium and provide no additional clearance for inadvertent movement.

C. PROVISIONS FOR INADVERTENT MOVEMENT

The minimum approach distances (working distances) must 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. A certain allowance must be made to account for this possible inadvertent movement and to provide the worker with a comfortable and safe zone in which to work. A distance for inadvertent movement (called the "ergonomic component of the minimum approach distance") must be added to the electrical component to determine the total safe minimum approach distances used in live-line work.

One approach that can be used to estimate the ergonomic component of the minimum approach distance is response time-distance analysis. When this technique is used, the total response time to a hazardous incident is estimated and converted to distance travelled. 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 a distance being travelled before the car comes to a complete stop. This distance is dependent on the speed of the car at the time the stimulus appears.

In the case of live-line work, the employee must first perceive that he or she is approaching the danger zone. Then, the worker responds to the danger and must decelerate and stop all motion toward the energized part. During the

time it takes to stop, a distance will have been traversed. It is this distance that must be added to the electrical component of the minimum approach distance to obtain the total safe minimum approach distance.

At voltages below 72.5 kV, the electrical component of the minimum approach distance is smaller than the ergonomic component. At 72.5 kV the electrical component is only a little more than 1 foot. An ergonomic component of the minimum approach distance is needed that will provide for all the worker's unexpected movements. The usual live-line work method for these voltages is the use of rubber insulating equipment, frequently rubber gloves. The energized object needs to be far enough away to provide the worker's face with a safe approach distance, as his or her hands and arms are insulated. In this case, 2 feet has been accepted as a sufficient and practical value.

For voltages between 72.6 and 800 kV, there is a change in the work practices employed during energized line work. Generally, live-line tools (hot sticks) are employed to perform work while equipment is energized. 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 length of the ergonomic component of the minimum approach distance is also influenced by the location of the worker and by the nature of the work. In these higher voltage ranges, the employees use work methods that more tightly control their movements than when the workers perform rubber glove work. The worker is farther from energized line or equipment and needs to be more precise in his or her movements just to perform the work.

For these reasons, a smaller ergonomic component of the minimum approach distance is needed, and a distance of 1 foot has been selected for voltages between 72.6 and 800 kV.

Table 4 summarizes the ergonomic component of the minimum approach distance for the two voltage ranges.

TABLE 4. - ERGONOMIC COMPONENT OF MINIMUM APPROACH DISTANCE

Voltage range (kV)	Distance (feet)
1.1 to 72.5	2.0
72.6 to 800	1.0

NOTE: This distance must be added to the electrical component of the minimum approach distance to obtain the full minimum approach distance.

D. BARE-HAND LIVE-LINE MINIMUM APPROACH DISTANCES

Calculating the strength of phase-to-phase transient overvoltages is complicated by the varying time displacement between overvoltages on parallel conductors (electrodes) and by the varying ratio between the positive and negative voltages on the two electrodes. The time displacement causes the maximum voltage between phases to be less than the sum of the phase-to-ground voltages. The International Electrotechnical Commission (IEC) Technical Committee 28, Working Group 2, has developed the following formula for determining the phase-to-phase maximum transient overvoltage, based on the per unit (p.u.) of the system nominal voltage phase-to-ground crest:

$$pu_p = pu_g + 1.6.$$

Where: pu_g = p.u. phase-to-ground maximum transient overvoltage
 pu_p = p.u. phase-to-phase maximum transient overvoltage

This value of maximum anticipated transient overvoltage must be used in Equation (2) to calculate the phase-to-phase minimum approach distances for live-line bare-hand work.

E. COMPILING THE MINIMUM APPROACH DISTANCE TABLES

For each voltage involved, the distance in Table 4 in this appendix has been added to the distance in Table 1, Table 2 or Table 3 in this appendix to determine the resulting minimum approach distances in Table R-6, Table R-7, and Table R-8 in §1910.269.

F. MISCELLANEOUS CORRECTION FACTORS

The strength of an air gap is influenced by the changes in the air medium that forms the insulation. A brief discussion of each factor follows, with a summary at the end.

1. DIELECTRIC STRENGTH OF AIR. The dielectric strength of air in a uniform electric field at standard atmospheric conditions is approximately 31 kV (crest) per cm at 60 Hz. The disruptive gradient is affected by the air pressure, temperature, and humidity, by the shape, dimensions, and separation of the electrodes, and by the characteristics of the applied voltage (wave shape).

2. ATMOSPHERIC EFFECT. Flashover for a given air gap is inhibited by an increase in the density (humidity) of the air. The empirically determined electrical strength of a given gap is normally applicable at standard atmospheric conditions (20°C, 101.3 kPa, 11 g/cm³ humidity).

The combination of temperature and air pressure that gives the lowest gap flashover voltage is high temperature and low pressure. These are conditions not likely to occur simultaneously. Low air pressure is generally associated with high humidity, and this causes increased electrical strength. An average air pressure is more likely to be associated with low humidity. Hot and dry working conditions are thus normally associated with reduced electrical strength.

The electrical component of the minimum approach distances in Table 1, Table 2, and Table 3 has been calculated using the maximum transient overvoltages to determine withstand voltages at standard atmospheric conditions.

3. ALTITUDE. The electrical strength of an air gap is reduced at high altitude, due principally to the reduced air pressure. An increase of about 3 percent per 300 meters in the minimum approach distance for altitudes above 900 meters is required. Table R-10 of §1910.269 presents this information in tabular form.

SUMMARY. After taking all these correction factors into account and after considering their interrelationships relative to the air gap insulation strength and the conditions under which live work is performed, one finds that only a correction for altitude need be made. An elevation of 900 meters is established as the base elevation, and the values of the electrical component of the minimum approach distances has been derived with this correction factor in mind. Thus, the values used for elevations below 900 meters are conservative without any change; corrections have to be made only above this base elevation.

IV. DETERMINATION OF REDUCED MINIMUM APPROACH DISTANCES

A. FACTORS AFFECTING VOLTAGE STRESS AT THE WORK SITE

1. SYSTEM VOLTAGE (NOMINAL). The nominal system voltage range sets the absolute lower limit for the minimum approach distance. The highest value within the range, as given in the relevant table, is selected and used as a reference for per unit calculations.

2. TRANSIENT OVERVOLTAGES. Transient overvoltages may be generated on an electrical system by the operation of switches or breakers, by the occurrence of a fault on the line or circuit being worked or on an adjacent circuit, and by similar activities. Most of the overvoltages are caused by switching, and the term "switching surge" is often used to refer generically to all types of overvoltages. However, each overvoltage has an associated transient voltage wave shape. The wave shape arriving at the site and its magnitude vary considerably.

The information used in the development of the minimum approach distances takes into consideration the most common wave shapes; thus, the required minimum approach distances are appropriate for any transient overvoltage level usually found on electric power generation, transmission, and distribution systems. The values of the per unit (p.u.) voltage relative to the nominal maximum voltage are used in the calculation of these distances.

3. TYPICAL MAGNITUDE OF OVERVOLTAGES. The magnitude of typical transient overvoltages is given in Table 5.

4. STANDARD DEVIATION - AIR-GAP WITHSTAND. For each air gap length, and under the same atmospheric conditions, there is a statistical variation in the breakdown voltage. The probability of the breakdown voltage is assumed to have 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 used in calculating the electrical component of the minimum approach distance has been set at three standard deviations ($3F^1$) below the critical flashover voltage. (The critical flashover voltage is the crest value of the impulse wave that, under specified conditions, causes flashover on 50 percent of the applications. An impulse wave of three standard deviations below this value, that is, the withstand voltage, has a probability of flashover of approximately 1 in 1000.)

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 multi-step resistor	2.5
Reclosed with trapped charge one step resistor	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 - 1.9

Source: ANSI/IEEE Standard No. 516, 1987.

5. **BROKEN INSULATORS.** Tests have shown that the insulation strength of an insulator string with broken skirts is reduced. Broken units may have lost up to 70% of their withstand capacity. Because the insulating capability of a broken unit cannot be determined without testing it, damaged units in an insulator are usually considered to have no insulating value. Additionally, the overall insulating strength of a string with broken units may be further reduced in the presence of a live-line tool alongside it. The number of good units that must be present in the string is based on the maximum overvoltage possible at the worksite.

B. MINIMUM APPROACH DISTANCES BASED ON KNOWN MAXIMUM ANTICIPATED PER-UNIT TRANSIENT OVERVOLTAGES

1. **REDUCTION OF THE MINIMUM APPROACH DISTANCE FOR AC SYSTEMS.** When the transient overvoltage values are known and supplied by the employer, Table R-7 and Table R-8 of §1910.269 allow the minimum approach distances from energized parts to be reduced. In order to determine what this maximum overvoltage is, the employer must undertake an engineering analysis of the system. As a result of this engineering study, the employer must provide new live work procedures, reflecting the new minimum approach distance, the conditions and limitations of application of the new minimum approach distances, and the specific practices to be used when these procedures are implemented.

¹ Sigma, F, is the symbol for standard deviation.

2. **CALCULATION OF REDUCED APPROACH DISTANCE VALUES.** The following method of calculating reduced minimum approach distance is based on ANSI/IEEE Standard 516:

STEP 1. Determine the maximum voltage (with respect to a given nominal voltage range) for the energized part.

STEP 2. Determine the maximum transient overvoltage (normally a switching surge) that can be present at the work site during work operation.

STEP 3. Determine the technique to be used to control the maximum transient overvoltage. (See paragraphs IV.C and IV.D of this appendix.) Determine the maximum voltage that can exist at the work site with that form of control in place and with a confidence level of 3F. This voltage is considered to be the withstand voltage for the purpose of calculating the appropriate minimum approach distance.

STEP 4. Specify in detail the control technique to be used, and direct its implementation during the course of the work.

STEP 5. Using the new value of transient overvoltage in per unit (p.u.), determine the required phase-to-ground minimum approach distance from Table R-7 or Table R-8 of §1910.269.

C. METHODS OF CONTROLLING POSSIBLE TRANSIENT OVERVOLTAGE STRESS FOUND ON A SYSTEM

1. INTRODUCTION. There are several means of controlling overvoltages that occur on transmission systems. First, the operation of circuit breakers or other switching devices may be modified to reduce switching transient overvoltages. Second, the overvoltage itself may be forcibly held to an acceptable level by means of installation of surge arresters at the specific location to be protected. Third, the transmission system may be changed to minimize the effect of switching operations.

2. OPERATION OF CIRCUIT BREAKERS.² The maximum transient overvoltage that can reach the work site is often due to switching on the line on which work is being performed. If the automatic-reclosing is removed during energized line work so that the line will not be re-energized after being opened for any reason, the maximum switching surge overvoltage is then limited 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. It is essential that the operating ability of such devices be assured when they are employed to limit the overvoltage level. If it is prudent not to remove 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 work is being performed. The coupling to adjacent lines must be accounted for when minimum approach distances are calculated based on the maximum transient overvoltage.

3. SURGE ARRESTERS. The use of modern surge arresters has permitted 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 that may be caused by switching or faults.

It is possible to use properly designed arresters to control transient overvoltages along a transmission line and thereby reduce the requisite length of the insulator string. On the other hand, if the installation of arresters has not been used to reduce the length of the insulator string, it may be used to reduce the minimum approach distance instead.³

4. SWITCHING RESTRICTIONS. Another form of overvoltage control is the establishment of switching restrictions, under which breakers are not permitted to be operated until certain system conditions are satisfied. Restriction of switching is achieved by the use of 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 are used to indicate that operation is not prevented, but only modified during the live-work activity.

D. MINIMUM APPROACH DISTANCE BASED ON CONTROL OF VOLTAGE STRESS (OVERVOLTAGES) AT THE WORK SITE.

Reduced minimum approach distances can be calculated as follows:

1. FIRST METHOD - DETERMINING THE REDUCED MINIMUM APPROACH DISTANCE FROM A GIVEN WITHSTAND VOLTAGE.⁴

STEP 1. Select the appropriate withstand voltage for the protective gap based on system requirements and an acceptable probability of actual gap flashover.

²The detailed design of a circuit interrupter, such as the design of the contacts, of resistor insertion, and of breaker timing control, are beyond the scope of this appendix. These features are routinely provided as part of the design for the system. Only features that can limit the maximum switching transient overvoltage on a system are discussed in this appendix.

³Surge arrester application is beyond the scope of this appendix. However, if the arrester is installed near the work site, the application would be similar to protective gaps as discussed in paragraph IV.D. of this appendix.

STEP 2. Determine a gap distance that provides a withstand voltage⁵ greater than or equal to the one selected "in the first step."⁶

STEP 3. Using 110 percent of the gap's critical flashover voltage, determine the electrical component of the minimum approach distance from Equation (2) or Table 6, which is a tabulation of distance vs. withstand voltage based on Equation (2).

STEP 4. Add the 1-foot ergonomic component to obtain the total minimum approach distance to be maintained by the employee.

2. SECOND METHOD - DETERMINING THE NECESSARY PROTECTIVE GAP LENGTH FROM A DESIRED (REDUCED) MINIMUM APPROACH DISTANCE.

STEP 1. Determine the desired minimum approach distance for the employee. Subtract the 1-foot ergonomic component of the minimum approach distance.

STEP 2. Using this distance, calculate the air gap withstand voltage from Equation (2). Alternatively, find the voltage corresponding to the distance in Table 6.⁷

STEP 3. Select a protective gap distance corresponding to a critical flashover voltage that, when multiplied by 110 percent, is less than or equal to the withstand voltage from Step 2.

STEP 4. Calculate the withstand voltage of the protective gap (85 percent of the critical flashover voltage) to ensure that it provides an acceptable risk of flashover during the time the gap is installed.

⁴Since a given rod gap of a given configuration corresponds to a certain withstand voltage, this method can also be used to determine the minimum approach distance for a known gap.

⁵The withstand voltage for the gap is equal to 85 percent of its critical flashover voltage.

⁶Switch steps 1 and 2 if the length of the protective gap is known. The withstand voltage must then be checked to ensure that it provides an acceptable probability of gap flashover. In general, it should be at least 1.25 times the maximum crest operating voltage.

⁷Since the value of the saturation factor, a , in Equation (2) is dependent on the maximum voltage, several iterative computations may be necessary to determine the correct withstand voltage using the equation. A graph of withstand voltage vs. distance is given in ANSI/IEEE Std. 516, 1987. This graph could also be used to determine the appropriate withstand voltage for the minimum approach distance involved.

TABLE 6. - WITHSTAND DISTANCES FOR TRANSIENT OVERVOLTAGES

Crest voltage (kV)	Withstand distance (in feet) air gap
100	0.71
150	1.06
200	1.41
250	1.77
300	2.12
350	2.47
400	2.83
450	3.18
500	3.54
550	3.89
600	4.24
650	4.60
700	5.17
750	5.73
800	6.31
850	6.91
900	7.57
950	8.23
1000	8.94
1050	9.65
1100	10.42
1150	11.18
1200	12.05
1250	12.90
1300	13.79
1350	14.70
1400	15.64
1450	16.61
1500	17.61
1550	18.63

Source: Calculations are based on Equation (2).

NOTE: The air gap is based on the 60-Hz rod-gap withstand distance.

3. SAMPLE PROTECTIVE GAP CALCULATIONS.

PROBLEM 1: Work is to be performed on a 500-kV transmission line that is subject to transient overvoltages of 2.4 p.u. The maximum operating voltage of the line is 552 kV. 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 line-to-ground voltage):⁸

⁸To eliminate unwanted flashovers due to minor system disturbances, it is desirable to have the crest withstand voltage no lower than 1.25 p.u.

$$552 \text{ kV} \times \frac{2}{\sqrt{3}} \times 1.25 = 563 \text{ kV}.$$

This will be the withstand voltage of the protective gap.

STEP 2. Using test data for a particular protective gap, select a gap that has a critical flashover voltage greater than or equal to:

$$563 \text{ kV} \div 0.85 = 662 \text{ kV.}$$

For example, if a protective gap with a 4.0-foot spacing tested to a critical flashover voltage of 665 kV, crest, select this gap spacing.

STEP 3. This protective gap corresponds to a 110 percent of critical flashover voltage value of:

$$665 \text{ kV} \times 1.10 = 732 \text{ kV.}$$

This corresponds to the withstand voltage of the electrical component of the minimum approach distance.

STEP 4. Using this voltage in Equation (2) results in an electrical component of the minimum approach distance of:

$$D = (0.01 + 0.0006) \times \frac{552 \text{ kV}}{3} = 5.5 \text{ ft.}$$

3

STEP 5. Add 1 foot to the distance calculated in step 4, resulting in a total minimum approach distance of 6.5 feet.

PROBLEM 2: For a line operating at a maximum voltage of 552 kV subject to a maximum transient overvoltage of 2.4 p.u., find a protective gap distance that will permit the use of a 9.0-foot minimum approach distance. (A minimum approach distance of 11 feet, 3 inches is normally required.)

STEP 1. The electrical component of the minimum approach distance is 8.0 feet (9.0-1.0).

STEP 2. From Table 6, select the withstand voltage corresponding to a distance of 8.0 feet. By interpolation:

$$900 \text{ kV} + \left[\frac{50 \times (8.00 - 7.57)}{(8.23 - 7.57)} \right] = 933 \text{ kV.}$$

STEP 3. The voltage calculated in Step 2 corresponds to 110 percent of the critical flashover voltage of the gap that should be employed. Using test data for a particular protective gap, select a gap that has a critical flashover voltage less than or equal to:

$$D = (0.01 + 0.0006) \times 732 \text{ kV} \div 2$$

For example, if a protective gap with a 5.8-foot spacing tested to a critical flashover voltage of 820 kV, crest, select this gap spacing.

STEP 4. The withstand voltage of this protective gap would be:

$$820 \text{ kV} \times 0.85 = 697 \text{ kV.}$$

The maximum operating crest voltage would be:

$$552 \text{ kV} \times \frac{2}{3} = 449 \text{ kV,}$$

The crest withstand voltage of the protective gap in per unit is thus:

$$697 \text{ kV} + 449 \text{ kV} = 1.55 \text{ p.u.}$$

If this is acceptable, the protective gap could be installed with a 5.8-foot spacing, and the minimum approach distance could then be reduced to 9.0 feet.

4. COMMENTS AND VARIATIONS. The 1-foot ergonomic component of the minimum approach distance must be added to the electrical component of the minimum approach distance calculated under paragraph IV.D of this appendix. The calculations may be varied by starting with the protective gap distance or by starting with the minimum approach distance.

E. LOCATION OF PROTECTIVE GAPS

1. Installation of the protective gap on a structure adjacent to the work site is an acceptable practice, as this does not significantly reduce the protection afforded by the gap.

2. Gaps installed at terminal stations of lines or circuits provide a given level of protection. The level may not, however, extend throughout the length of the line to the worksite. The use of gaps at terminal stations must be studied in depth. 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 flashover. When voltage surges are initiated 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 that is installed within 0.5 mile of the work site will protect against such intersecting waves. Engineering studies of a particular line or system may indicate that adequate protection can be provided by even more distant gaps.

3. If protective gaps are used at the work site, the work site impulse insulation strength is established by the gap setting. Lightning strikes as much as 6 miles away from the worksite may cause a voltage surge greater than the insulation withstand voltage, and a gap flashover may occur. The flashover will not occur between the employee and the line, but across the protective gap instead.

4. There are two reasons to disable the automatic-reclosing feature of circuit-interrupting devices while employees are performing live-line maintenance:

- To prevent the reenergizing of a circuit faulted by actions of a worker, which could possibly create a hazard or compound injuries or damage produced by the original fault;
- To prevent any transient overvoltage caused by the switching surge that would occur if the circuit were reenergized.

However, due to system stability considerations, it may not always be feasible to disable the automatic-reclosing feature.

APPENDIX C TO §1910.269 - PROTECTION FROM STEP AND TOUCH POTENTIALS

I. INTRODUCTION

When a ground fault occurs on a power line, voltage is impressed on the "grounded" object faulting the line. The voltage to which this object rises 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 object causing the fault represents a relatively large impedance, the voltage impressed on it is essentially the phase-to-ground system voltage. However, even faults to well grounded transmission towers or substation structures can result in hazardous voltages.¹ The degree of the hazard depends upon the magnitude of the fault current and the time of exposure.

II. VOLTAGE-GRADIENT DISTRIBUTION

A. VOLTAGE-GRADIENT DISTRIBUTION CURVE

The dissipation of voltage from a grounding electrode (or from the grounded end of an energized grounded object) is called the ground potential gradient. Voltage drops associated with this dissipation of voltage are called ground potentials. Figure 1 is a typical voltage-gradient distribution curve (assuming a uniform soil texture). This graph shows that voltage decreases rapidly with increasing distance from the grounding electrode.

B. STEP AND TOUCH POTENTIALS

"Step potential" is the voltage between the feet of a person standing near an energized grounded object. It is equal to the difference in voltage, given by the voltage distribution curve, between two points at different distances from the "electrode". A person could be at risk of injury during a fault simply by standing near the grounding point.

"Touch potential" is the voltage between the energized object and the feet of a person in contact with the object. It is equal to the difference in voltage between the object (which is at a distance of 0 feet) and a point some distance away. It should be noted that 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 that was grounded to the system neutral and that contacted 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.

Step and touch potentials are illustrated in Figure 2.

¹This appendix provides information primarily with respect to employee protection from contact between equipment being used and an energized power line. The information presented is also relevant to ground faults to transmission towers and substation structures; however, grounding systems for these structures should be designed to minimize the step and touch potentials involved.

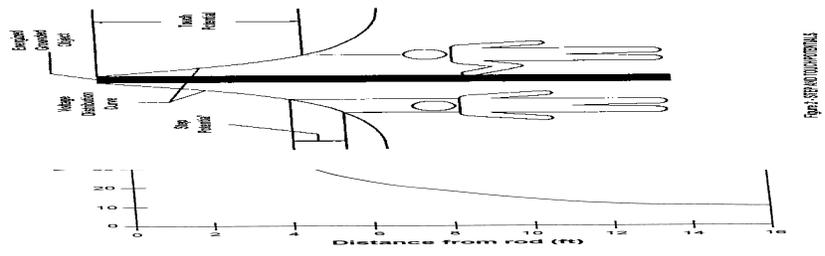


Figure 1 - TYPICAL VOLTAGE-GRADIENT DISTRIBUTION CURVE

C. PROTECTION FROM THE HAZARDS OF GROUND-POTENTIAL GRADIENTS

An engineering analysis of the power system under fault conditions can be used to determine whether or not hazardous step and touch voltages will develop. The result of this analysis can ascertain the need for protective measures and can guide the selection of appropriate precautions.

Several methods may be used to protect employees from hazardous ground-potential gradients, including equipotential zones, insulating equipment, and restricted work areas.

1. The creation of an equipotential zone will protect a worker standing within it from hazardous step and touch potentials. (See Figure 3.) Such a zone can be produced through the use of a metal mat connected to the grounded object. In some cases, a grounding grid can be used to equalize the voltage within the grid. Equipotential zones will not, however, protect employees who are either wholly or partially outside the protected area. Bonding conductive objects in the immediate work area can also be used 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 in some cases, however.)

2. The use of insulating equipment, such as rubber gloves, can protect employees handling grounded equipment and conductors from hazardous touch potentials. The insulating equipment must 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 the operation being performed. Employees on the ground in the vicinity of transmission structures should be kept at a distance where step voltages would be insufficient to cause injury. Employees should not handle grounded conductors or equipment likely to become energized to hazardous voltages unless the employees are within an equipotential zone or are protected by insulating equipment.

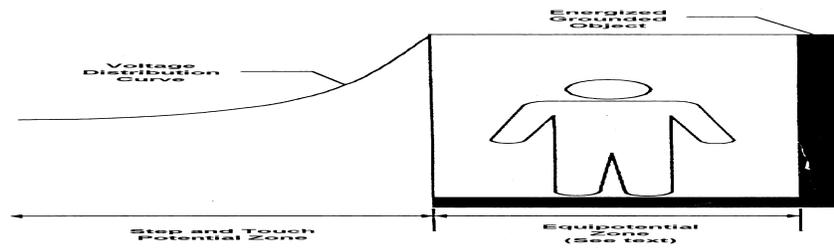


Figure 3 - PROTECTION FROM GROUND-POTENTIAL GRADIENTS

APPENDIX D TO SECTION 1910.269 - METHODS OF INSPECTING AND TESTING WOOD POLES

I. INTRODUCTION

When work is to be performed on a wood pole, it is important to determine the condition of the pole before it is climbed. The weight of the employee, the weight of equipment being installed, and other working stresses (such as the removal or retensioning of conductors) can lead to the failure of a defective pole or one that is not designed to handle the additional stresses.¹ For these reasons, it is essential that an inspection and test of the condition of a wood pole be performed before it is climbed.

If the pole is found to be unsafe to climb or to work from, it must be secured so that it does not fail while an employee is on it. The pole can be secured by a line truck boom, by ropes or guys, or by lashing a new pole alongside it. If a new one is lashed alongside the defective pole, work should be performed from the new one.

II. INSPECTION OF WOOD POLES

Wood poles should be inspected by a qualified employee for the following conditions:²

A. GENERAL CONDITION

The pole should be inspected for buckling at the ground line and for an unusual angle with respect to the ground. Buckling and odd angles may indicate that the pole has rotted or is broken.

B. CRACKS

The pole should be inspected for cracks. Horizontal cracks perpendicular to the grain of the wood may weaken the pole. Vertical ones, although not considered to be a sign of a defective pole, can pose a hazard to the climber, and the employee should keep his or her gaffs away from them while climbing.

C. HOLES

Hollow spots and woodpecker holes can reduce the strength of a wood pole.

D. SHELL ROT AND DECAY

Rotting and decay are cutout hazards and are possible indications of the age and internal condition of the pole.

E. KNOTS

One large knot or several smaller ones at the same height on the pole may be evidence of a weak point on the pole.

F. DEPTH OF SETTING

Evidence of the existence of a former ground line substantially above the existing ground level may be an indication that the pole is no longer buried to a sufficient extent.

G. SOIL CONDITIONS

Soft, wet, or loose soil may not support any changes of stress on the pole.

¹A properly guyed pole in good condition should, at a minimum, be able to handle the weight of an employee climbing it.

²The presence of any of these conditions is an indication that the pole may not be safe to climb or to work from. The employee performing the inspection must be qualified to make a determination as to whether or not it is safe to perform the work without taking additional precautions.

H. BURN MARKS

Burning from transformer failures or conductor faults could damage the pole so that it cannot withstand mechanical stress changes.

III. TESTING OF WOOD POLES

The following tests, which have been taken from §1910.268(n)(3), are recognized as acceptable methods of testing wood poles:

A. HAMMER TEST

Rap the pole sharply with a hammer weighing about 3 pounds, starting near the ground line and continuing upwards circumferentially around the pole to a height of approximately 6 feet. The hammer will produce a clear sound and rebound sharply when striking sound wood. Decay pockets will be indicated by a dull sound or a less pronounced hammer rebound. Also, prod the pole as near the ground line as possible using a pole prod or a screwdriver with a blade at least 5 inches long. If substantial decay is encountered, the pole is considered unsafe.

B. ROCKING TEST

Apply a horizontal force to the pole and attempt to rock it back and forth in a direction perpendicular to the line. Caution must be exercised to avoid causing power lines to swing together. The force may be applied either by pushing with a pike pole or pulling with a rope. If the pole cracks during the test, it shall be considered unsafe.

APPENDIX E TO SECTION 1910.269 - REFERENCE DOCUMENTS

The references contained in this appendix provide information that can be helpful in understanding and complying with the requirements contained in §1910.269. The national consensus standards referenced in this appendix contain detailed specifications that employers may follow in complying with the more performance-oriented requirements of OSHA's final rule. Except as specifically noted in §1910.269, however, compliance with the national consensus standards is not a substitute for compliance with the provisions of the OSHA standard.

ANSI/SIA A92.2-1990, American National Standard for Vehicle-Mounted Elevating and Rotating Aerial Devices.

ANSI C2-1993, National Electrical Safety Code.

ANSI Z133.1-1988, American National Standard Safety Requirements for Pruning, Trimming, Repairing, Maintaining, and Removing Trees, and for Cutting Brush.

ANSI/ASME B20.1-1990, Safety Standard for Conveyors and Related Equipment.

ANSI/IEEE Std. 4-1978 (Fifth Printing), IEEE Standard Techniques for High-Voltage Testing.

ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms.

ANSI/IEEE Std. 516-1987, IEEE Guide for Maintenance Methods on Energized Power-Lines.

ANSI/IEEE Std. 935-1989, IEEE Guide on Terminology for Tools and Equipment to Be Used in Live Line Working.

ANSI/IEEE Std. 957-1987, IEEE Guide for Cleaning Insulators.

ANSI/IEEE Std. 978-1984 (R1991), IEEE Guide for In-Service Maintenance and Electrical Testing of Live-Line Tools.

ASTM D 120-87, Specification for Rubber Insulating Gloves.

ASTM D 149-92, Test Method of Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.

ASTM D 178-93, Specification for Rubber Insulating Matting.

ASTM D 1048-93, Specification for Rubber Insulating Blankets.

ASTM D 1049-93, Specification for Rubber Insulating Covers.

ASTM D 1050-90, Specification for Rubber Insulating Line Hose.

ASTM D 1051-87, Specification for Rubber Insulating Sleeves.

ASTM F 478-92, Specification for In-Service Care of Insulating Line Hose and Covers.
ASTM F 479-93, Specification for In-Service Care of Insulating Blankets.
ASTM F 496-93b, Specification for In-Service Care of Insulating Gloves and Sleeves.
ASTM F 711-89, Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools.
ASTM F 712-88, Test Methods for Electrically Insulating Plastic Guard Equipment for Protection of Workers.
ASTM F 819-83a (1988), Definitions of Terms Relating to Electrical Protective Equipment for Workers.
ASTM F 855-90, Specifications for Temporary Grounding Systems to Be Used on Deenergized Electric Power Lines and Equipment.
ASTM F 887-91a, Specifications for Personal Climbing Equipment.
ASTM F 914-91, Test Method for Acoustic Emission for Insulated Aerial Personnel Devices.
ASTM F 968-93, Specification for Electrically Insulating Plastic Guard Equipment for Protection of Workers.
ASTM F 1116-88, Test Method for Determining Dielectric Strength of Overshoe Footwear.
ASTM F 1117-87, Specification for Dielectric Overshoe Footwear.
ASTM F 1236-89, Guide for Visual Inspection of Electrical Protective Rubber Products.
ASTM F 1505-94, Standard Specification for Insulated and Insulating Hand Tools.
ASTM F 1506-94, Standard Performance Specification for Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards.
IEEE Std. 62-1978, IEEE Guide for Field Testing Power Apparatus Insulation.
IEEE Std. 524-1992, IEEE Guide to the Installation of Overhead Transmission Line Conductors.
IEEE Std. 1048-1990. IEEE Guide for Protective Grounding of Power Lines
IEEE Std. 1067-1990, IEEE Guide for the In-Service Use, Care, Maintenance, and Testing of Conductive Clothing for Use on Voltages up to 765 kV AC.

[59 FR 4437, Jan. 31, 1994; 59 FR 33658, June 30, 1994]

EFFECTIVE DATE NOTE: At 59 FR 4437, Jan. 31, 1994, §1910.269 was added, effective May 31, 1994. Paragraph (a)(2) of this section will become effective January 31, 1995.

**APPENDIX B TO CODE 11 - 29 C.F.R. §1926.950 SUBPART V -
POWER TRANSMISSION AND DISTRIBUTION**

AUTHORITY: Sec. 107, Contract Work Hours and Safety Standards Act (Construction Safety Act) (40 U.S.C. 333); secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12-71 (36 FR 8754), 8-76 (41 FR 25059), or 9-83 (48 FR 35736), as applicable.

§1926.950 GENERAL REQUIREMENTS.

(a) APPLICATION. The occupational safety and health standards contained in this Subpart V shall apply to the construction of electric transmission and distribution lines and equipment.

(1) As used in this Subpart V the term "construction" includes the erection of new electric transmission and distribution lines and equipment, and the alteration, conversion, and improvement of existing electric transmission and distribution lines and equipment.

(2) Existing electric transmission and distribution lines and electrical equipment need not be modified to conform to the requirements of applicable standards in this Subpart V, until such work as described in paragraph (a)(1) of this section is to be performed on such lines or equipment.

(3) The standards set forth in this Subpart V provide minimum requirements for safety and health. Employers may require adherence to additional standards which are not in conflict with the standards contained in this Subpart V.

(b) INITIAL INSPECTIONS, TESTS, OR DETERMINATIONS. (1) Existing conditions shall be determined before starting work, by an inspection or a test. Such conditions shall include, but not be limited to, energized lines and equipment, conditions of poles, and the location of circuits and equipment, including power and communication lines, CATV and fire alarm circuits.

(2) Electric equipment and lines shall be considered energized until determined to be deenergized by tests or other appropriate methods or means.

(3) Operating voltage of equipment and lines shall be determined before working on or near energized parts.

(c) CLEARANCES. The provisions of paragraph (c)(1) or (2) of this section shall be observed.

(1) No employee shall be permitted to approach or take any conductive object without an approved insulating handle closer to exposed energized parts than shown in Table V-1, unless:

(i) The employee is insulated or guarded from the energized part (gloves or gloves with sleeves rated for the voltage involved shall be considered insulation of the employee from the energized part), or

(ii) The energized part is insulated or guarded from him and any other conductive object at a different potential, or

(iii) The employee is isolated, insulated, or guarded from any other conductive object(s), as during live-line bare-hand work.

(2) (i) The minimum working distance and minimum clear hot stick distances stated in Table V-1 shall not be violated. The minimum clear hot stick distance is that for the use of live-line tools held by linemen when performing live-line work.

(ii) Conductor support tools, such as link sticks, strain carriers, and insulator cradles, may be used: PROVIDED, That the clear insulation is at least as long as the insulator string or the minimum distance specified in Table V-1 for the operating voltage.

TABLE V-1 - ALTERNATING CURRENT - MINIMUM DISTANCES

Voltage range (phase to phase) kilovolt	Minimum working and clear hot stick distance
2.1 to 15 15.1 to 35 35.1 to 46 46.1 to 72.5 72.6 to 121 138 to 145 161 to 169 230 to 242 345 to 362 500 to 552 700 to 765	2 ft. 0 in. 2 ft. 4 in. 2 ft. 6 in. 3 ft. 0 in. 3 ft. 4 in. 3 ft. 6 in. 3 ft. 8 in. 5 ft. 0 in. ¹ 7 ft. 0 in. ¹ 11 ft. 0 in. ¹ 15 ft. 0 in.
¹ NOTE: For 345-362 kv., 500-552 kv., and 700-765 kv., the minimum working distance and the minimum clear hot stick distance may be reduced provided that such distances are not less than the shortest distance between the energized part of a grounded surface.	

(d) DEENERGIZING LINES AND EQUIPMENT. (1) When deenergizing lines and equipment operated in excess of 600 volts, and the means of disconnecting from electric energy is not visibly open or visibly locked out, the provisions of paragraphs (d)(1)(i) through (vii) of this section shall be complied with:

(i) The particular section of line or equipment to be deenergized shall be clearly identified, and it shall be isolated from all sources of voltage.

(ii) Notification and assurance from the designated employee shall be obtained that:

(a) All switches and disconnectors through which electric energy may be supplied to the particular section of line or equipment to be worked have been deenergized;

(b) All switches and disconnectors are plainly tagged indicating that men are at work;

(c) And that where design of such switches and disconnectors permits, they have been rendered inoperable.

(iii) After all designated switches and disconnectors have been opened, rendered inoperable, and tagged, visual inspection or tests shall be conducted to insure that equipment or lines have been deenergized.

(iv) Protective grounds shall be applied on the disconnected lines or equipment to be worked on.

(v) Guards or barriers shall be erected as necessary to adjacent energized lines..

(vi) When more than one independent crew requires the same line or equipment to be deenergized, a prominent tag for each such independent crew shall be placed on the line or equipment by the designated employee in charge.

(vii) Upon completion of work on deenergized lines or equipment, each designated employee in charge shall determine that all employees in his crew are clear, that protective grounds installed by his crew have been removed, and he shall report to the designated authority that all tags protecting his crew may be removed.

(2) When a crew working on a line or equipment can clearly see that the means of disconnecting from electric energy are visibly open or visibly locked-out, the provisions of paragraphs (d)(i), and (ii) of this section shall apply:

(i) Guards or barriers shall be erected as necessary to adjacent energized lines.

(ii) Upon completion of work on deenergized lines or equipment, each designated employee in charge shall determine that all employees in his crew are clear, that protective grounds installed by his crew have been removed, and he shall report to the designated authority that all tags protecting his crew may be

removed.

(e) EMERGENCY PROCEDURES AND FIRST AID. (1) The employer shall provide training or require that his employees are knowledgeable and proficient in:

- (i) Procedures involving emergency situations, and
- (ii) First-aid fundamentals including resuscitation.

(2) In lieu of paragraph (e)(1) of this section the employer may comply with the provisions of §1926.50(c) regarding first-aid requirements.

(f) NIGHT WORK. When working at night, spotlights or portable lights for emergency lighting shall be provided as needed to perform the work safely.

(g.) WORK NEAR AND OVER WATER. When crews are engaged in work over or near water and when danger of drowning exists, suitable protection shall be provided as stated in §1926.104, or §1926.105, or §1926.106.

(h) SANITATION FACILITIES. The requirements of §1926.51 of Subpart D of this part shall be complied with for sanitation facilities.

(i) HYDRAULIC FLUIDS. All hydraulic fluids used for the insulated sections of derrick trucks, aerial lifts, and hydraulic tools which are used on or around energized lines and equipment shall be of the insulating type. The requirements for fire resistant fluids of §1926.302(d)(1) do not apply to hydraulic tools covered by this paragraph.

§1926.951 TOOLS AND PROTECTIVE EQUIPMENT.

(a) PROTECTIVE EQUIPMENT. (1)(i) Rubber protective equipment shall be in accordance with the provisions of the American National Standards Institute (ANSI), ANSI J6 series, as follows:

Item	Standard
Rubber insulating gloves	J6.6-1971.
Rubber matting for use around electric apparatus	J6.7-1935 (R1971).
Rubber insulating blankets	J6.4-1971.
Rubber insulating hoods	J6.2-1950 (R1971).
Rubber insulating line hose	J6.1-1950 (R1971).
Rubber insulating sleeves	J6.5-1971.

(ii) Rubber protective equipment shall be visually inspected prior to use.

(iii) In addition, an "air" test shall be performed for rubber gloves prior to use.

(iv) Protective equipment of material other than rubber shall provide equal or better electrical and mechanical protection.

(2) Protective hats shall be in accordance with the provisions of ANSI Z89.2-1971 Industrial Protective Helmets for Electrical Workers, Class B, and shall be worn at the jobsite by employees who are exposed to the hazards of falling objects, electric shock, or burns.

(b) PERSONAL CLIMBING EQUIPMENT. (1) Body belts with straps or lanyards shall be worn to protect employees working at elevated locations on poles, towers, or other structures except where such use creates a greater hazard to the safety of the employees, in which case other safeguards shall be employed.

(2) Body belts and safety straps shall meet the requirements of §1926.959. In addition to being used as an employee safeguarding item, body belts with approved tool loops may be used for the purpose of holding tools. Body belts shall be free from additional metal hooks and tool loops other than those permitted in §1926.959.

(3) Body belts and straps shall be inspected before use each day to determine that they are in safe working condition.

(4)(i) Life lines and lanyards shall comply with the provisions of §1926.104.

(ii) Safety lines are not intended to be subjected to shock loading and are used for emergency

rescue such as lowering a man to the ground. Such safety lines shall be a minimum of one-half-inch diameter and three or four strand first-grade manila or its equivalent in strength (2,650 lbs.) and durability.

(5) Defective ropes shall be replaced.

(c) LADDERS. (1) Portable metal or conductive ladders shall not be used near energized lines or equipment except as may be necessary in specialized work such as in high voltage substations where nonconductive ladders might present a greater hazard than conductive ladders. Conductive or metal ladders shall be prominently marked as conductive and all necessary precautions shall be taken when used in specialized work.

(2) Hook or other type ladders used in structures shall be positively secured to prevent the ladder from being accidentally displaced.

(d) LIVE-LINE TOOLS. (1) Only live-line tool poles having a manufacturer's certification to withstand the following minimum tests shall be used:

(i) 100,000 volts per foot of length for 5 minutes when the tool is made of fiberglass; or

(ii) 75,000 volts per foot of length for 3 minutes when the tool is made of wood; or

(iii) Other tests equivalent to paragraph (d)(i) or (ii) of this section as appropriate.

(2) All live-line tools shall be visually inspected before use each day. Tools to be used shall be wiped clean and if any hazardous defects are indicated such tools shall be removed from service.

(e) MEASURING TAPES OR MEASURING ROPES. Measuring tapes or measuring ropes which are metal or contain conductive strands shall not be used when working on or near energized parts.

(f) HANDTOOLS. (1) Switches for all powered hand tools shall comply with §1926.300 (d).

(2) All portable electric handtools shall:

(i) Be equipped with three-wire cord having the ground wire permanently connected to the tool frame and means for grounding the other end; or

(ii) Be of the double insulated type and permanently labeled as "Double Insulated"; or

(iii) Be connected to the power supply by means of an isolating transformer, or other isolated power supply.

(3) All hydraulic tools which are used on or around energized lines or equipment shall use nonconducting hoses having adequate strength for the normal operating pressures. It should be noted that the provisions of §1926.302(d)(2) shall also apply.

(4) All pneumatic tools which are used on or around energized lines or equipment shall:

(i) Have nonconducting hoses having adequate strength for the normal operating pressures, and

(ii) Have an accumulator on the compressor to collect moisture.

§1926.952 MECHANICAL EQUIPMENT.

(a) GENERAL. (1) Visual inspections shall be made of the equipment to determine that it is in good condition each day the equipment is to be used.

(2) Tests shall be made at the beginning of each shift during which the equipment is to be used to determine that the brakes and operating systems are in proper working condition.

(3) No employer shall use any motor vehicle equipment having an obstructed view to the rear unless:

(i) The vehicle has a reverse signal alarm audible above the surrounding noise level or:

(ii) The vehicle is backed up only when an observer signals that it is safe to do so.

(b) AERIAL LIFTS. (1) The provisions of §1926.556, Subpart N of this part, shall apply to the utilization of aerial lifts.

(2) When working near energized lines or equipment, aerial lift trucks shall be grounded or barricaded and considered as energized equipment, or the aerial lift truck shall be insulated for the work being performed.

(3) Equipment or material shall not be passed between a pole or structure and an aerial lift while an employee working from the basket is within reaching distance of energized conductors or equipment that are not covered with insulating protective equipment.

(c) DERRICK TRUCKS, CRANES AND OTHER LIFTING EQUIPMENT. (1) All derrick trucks, cranes and other lifting equipment shall comply with Subpart N and O of this part except:

(i) As stated in §1926.550(a)(15)(i) and (ii) relating to clearance (for clearances in this subpart

see Table V-1) and

(ii) Derrick truck (electric line trucks) shall not be required to comply with §1926.550(a)(7)(vi), (a)(17), (b)(2), and (e).

(2) With the exception of equipment certified for work on the proper voltage, mechanical equipment shall not be operated closer to any energized line or equipment than the clearances set forth in §1926.950(c) unless:

- (i) An insulated barrier is installed between the energized part and the mechanical equipment, or
- (ii) The mechanical equipment is grounded, or
- (iii) The mechanical equipment is insulated, or
- (iv) The mechanical equipment is considered as energized.

§1926.953 MATERIAL HANDLING

A. UNLOADING. Prior to unloading steel, poles, cross arms, and similar material, the load shall be thoroughly examined to ascertain if the load has shifted, binders or stakes have broken or the load is otherwise hazardous to employees.

(b) POLE HAULING. (1) During pole hauling operations, all loads shall be secured to prevent displacement and a red flag shall be displayed at the trailing end of the longest pole.

(2) Precautions shall be exercised to prevent blocking of roadways or endangering other traffic.

(3) When hauling poles during the hours of darkness, illuminated warning devices shall be attached to the trailing end of the longest pole.

(c) STORAGE. (1) No materials or equipment shall be stored under energized bus, energized lines, or near energized equipment, if it is practical to store them elsewhere.

(2) When materials or equipment are stored under energized lines or near energized equipment, applicable clearances shall be maintained as stated in Table V-1; and extraordinary caution shall be exercised when moving materials near such energized equipment.

(d) TAG LINE. Where hazards to employees exist tag lines or other suitable devices shall be used to control loads being handled by hoisting equipment.

(e) OIL FILLED EQUIPMENT. During construction or repair of oil filled equipment the oil may be stored in temporary containers other than those required in §1926.152, such as pillow tanks.

(f) FRAMING. During framing operations, employees shall not work under a pole or a structure suspended by a crane, A-frame or similar equipment unless the pole or structure is adequately supported.

(g) ATTACHING THE LOAD. The hoist rope shall not be wrapped around the load. This provision shall not apply to electric construction crews when setting or removing poles.

§1926.954 GROUNDING FOR PROTECTION OF EMPLOYEES.

(a) GENERAL. All conductors and equipment shall be treated as energized until tested or otherwise determined to be deenergized or until grounded.

(b) NEW CONSTRUCTION. New lines or equipment may be considered deenergized and worked as such where:

(1) The lines or equipment are grounded, or

(2) The hazard of induced voltages is not present, and adequate clearances or other means are implemented to prevent contact with energized lines or equipment and the new lines or equipment.

(c) COMMUNICATION CONDUCTORS. Bare wire communication conductors on power poles or structures shall be treated as energized lines unless protected by insulating materials.

(d) VOLTAGE TESTING. Deenergized conductors and equipment which are to be grounded shall be tested for voltage. Results of this voltage test shall determine the subsequent procedures as required in 1926.950(d).

(e) ATTACHING GROUNDS. (1) When attaching grounds, the ground end shall be attached first, and the other end shall be attached and removed by means of insulated tools or other suitable devices.

(2) When removing grounds, the grounding device shall first be removed from the line or equipment using insulating tools or other suitable devices.

(f) Grounds shall be placed between work location and all sources of energy and as close as

practicable to the work location, or grounds shall be placed at the work location. If work is to be performed at more than one location in a line section, the line section must be grounded and short circuited at one location in the line section and the conductor to be worked on shall be grounded at each work location. The minimum distance shown in Table V-1 shall be maintained from ungrounded conductors at the work location. Where the making of a ground is impracticable, or the conditions resulting therefrom would be more hazardous than working on the lines or equipment without grounding, the grounds may be omitted and the line or equipment worked as energized.

(g) TESTING WITHOUT GROUNDS. Grounds may be temporarily removed only when necessary for test purposes and extreme caution shall be exercised during the test procedures.

(h) GROUNDING ELECTRODE. When grounding electrodes are utilized, such electrodes shall have a resistance to ground low enough to remove the danger of harm to personnel or permit prompt operation of protective devices.

(i) GROUNDING TO TOWER. Grounding to tower shall be made with a tower clamp capable of conducting the anticipated fault current.

(i) GROUND LEAD. A ground lead, to be attached to either a tower ground or driven ground, shall be capable of conducting the anticipated fault current and shall have a minimum conductance of No. 2 AWG copper.

§1926.955 OVERHEAD LINES.

(a) OVERHEAD LINES. (1) When working on or with overhead lines the provisions of paragraphs (a)(2) through (8) of this section shall be complied with in addition to other applicable provisions of this subpart.

(2) Prior to climbing poles, ladders, scaffolds, or other elevated structures, an inspection shall be made to determine that the structures are capable of sustaining the additional or unbalanced stresses to which they will be subjected.

(3) Where poles or structures may be unsafe for climbing, they shall not be climbed until made safe by guying, bracing, or other adequate means.

(4) Before installing or removing wire or cable, strains to which poles and structures will be subjected shall be considered and necessary action taken to prevent failure of supporting structures.

(5)(i) When setting, moving, or removing poles using cranes, derricks, gin poles, A-frames, or other mechanized equipment near energized lines or equipment, precautions shall be taken to avoid contact with energized lines or equipment, except in bare-hand live-line work, or where barriers or protective devices are used.

(ii) Equipment and machinery operating adjacent to energized lines or equipment shall comply with §1926.952(c)(2).

(6)(i) Unless using suitable protective equipment for the voltage involved, employees standing on the ground shall avoid contacting equipment or machinery working adjacent to energized lines or equipment.

(ii) Lifting equipment shall be bonded to an effective ground or it shall be considered energized and barricaded when utilized near energized equipment or lines.

(7) Pole holes shall not be left unattended or unguarded in areas where employees are currently working.

(8) Tag lines shall be of a nonconductive type when used near energized lines.

(b) METAL TOWER CONSTRUCTION. (1) When working in unstable material the excavation for pad- or pile-type footings in excess of 5 feet deep shall be either sloped to the angle of repose as required in §1926.652 or shored if entry is required. Ladders shall be provided for access to pad- or pile-type footing excavations in excess of 4 feet.

(2) When working in unstable material provision shall be made for cleaning out auger-type footings without requiring an employee to enter the footing unless shoring is used to protect the employee.

(3)(i) A designated employee shall be used in directing mobile equipment adjacent to footing excavations.

(ii) No one shall be permitted to remain in the footing while equipment is being spotted for placement.

(iii) Where necessary to assure the stability of mobile equipment the location of use for such

equipment shall be graded and leveled.

(4)(i) Tower assembly shall be carried out with a minimum exposure of employees to falling objects when working at two or more levels on a tower.

(ii) Guy lines shall be used as necessary to maintain sections or parts of sections in position and to reduce the possibility of tipping.

(iii) Members and sections being assembled shall be adequately supported.

(5) When assembling and erecting towers the provisions of paragraphs (b)(5)(i), (ii) and (iii) of this section shall be complied with:

(i) 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 part.

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

(iii) When erecting towers using hoisting equipment adjacent to energized transmission lines, the lines shall be deenergized when practical. If the lines are not deenergized, extraordinary caution shall be exercised to maintain the minimum clearance distances required by §1926.950(c), including Table V-1.

(6)(i) Erection cranes shall be set on firm level foundations and when the cranes are so equipped outriggers shall be used.

(ii) Tag lines shall be utilized to maintain control of tower sections being raised and positioned, except where the use of such lines would create a greater hazard.

(iii) The loadline shall not be detached from a tower section until the section is adequately secured.

(iv) Except during emergency restoration procedures erection shall be discontinued in the event of high wind or other adverse weather conditions which would make the work hazardous.

(v) Equipment and rigging shall be regularly inspected and maintained in safe operating condition.

(7) Adequate traffic control shall be maintained when crossing highways and railways with equipment as required by the provisions of §1926.200(g)(1) and (2).

(8) A designated employee shall be utilized to determine that required clearance is maintained in moving equipment under or near energized lines.

(c) **STRINGING OR REMOVING DEENERGIZED CONDUCTORS.** (1) When stringing or removing deenergized conductors, the provisions of paragraphs (c) (2) through (12) of this section shall be complied with.

(2) Prior to stringing operations a briefing shall be held setting forth the plan of operation and specifying the type of equipment to be used, grounding devices and procedures to be followed, crossover methods to be employed, and the clearance authorization required.

(3) Where there is a possibility of the conductor accidentally contacting an energized circuit or receiving a dangerous induced voltage buildup, to further protect the employee from the hazards of the conductor, the conductor being installed or removed shall be grounded or provisions made to insulate or isolate the employee.

(4)(i) If the existing line is deenergized, proper clearance authorization shall be secured and the line grounded on both sides of the crossover or, the line being strung or removed shall be considered and worked as energized.

(ii) When crossing over energized conductors in excess of 600 volts, rope nets or guard structures shall be installed unless provision is made to isolate or insulate the workman or the energized conductor. Where practical the automatic reclosing feature of the circuit interrupting device shall be made inoperative. In addition, the line being strung shall be grounded on either side of the crossover or considered and worked as energized.

(5) Conductors being strung in or removed shall be kept under positive control by the use of adequate tension reels, guard structures, tielines, or other means to prevent accidental contact with energized circuits.

(6) Guard structure members shall be sound and of adequate dimension and strength, and adequately supported.

(7) (i) Catch-off anchors, rigging, and hoists shall be of ample capacity to prevent loss of the

lines.

(ii) The manufacturer's load rating shall not be exceeded for stringing lines, pulling lines, sock connections, and all load-bearing hardware and accessories.

(iii) Pulling lines and accessories shall be inspected regularly and replaced, or repaired when damaged or when dependability is doubtful. The provisions of §1926.251(c)(4)(ii) (concerning splices) shall not apply.

(8) Conductor grips shall not be used on wire rope unless designed for this application.

(9) While the conductor or pulling line is being pulled (in motion) employees shall not be permitted directly under overhead operations, nor shall any employee be permitted on the crossarm.

(10) A transmission clipping crew shall have a minimum of two structures clipped in between the crew and the conductor being sagged. When working on bare conductors, clipping and tying crews shall work between grounds at all times. The grounds shall remain intact until the conductors are clipped in, except on dead end structures.

(11) (i) Except during emergency restoration procedures, work from structures shall be discontinued when adverse weather (such as high wind or ice on structures) makes the work hazardous.

(ii) Stringing and clipping operations shall be discontinued during the progress of an electrical storm in the immediate vicinity.

(12) (i) Reel handling equipment, including pulling and braking machines, shall have ample capacity, operate smoothly, and be leveled and aligned in accordance with the manufacturer's operating instructions.

(ii) Reliable communications between the reel tender and pulling rig operator shall be provided.

(iii) Each pull shall be snubbed or dead ended at both ends before subsequent pulls.

(d) **STRINGING ADJACENT TO ENERGIZED LINES.** (1) Prior to stringing parallel to an existing energized transmission line a competent determination shall be made to ascertain whether dangerous induced voltage buildups will occur, particularly during switching and ground fault conditions. When there is a possibility that such dangerous induced voltage may exist the employer shall comply with the provisions of paragraphs (d) (2) through (9) of this section in addition to the provisions of paragraph (c) of this §1926.955, unless the line is worked as energized.

(2) When stringing adjacent to energized lines the tension stringing method or other methods which preclude unintentional contact between the lines being pulled and any employee shall be used.

(3) All pulling and tensioning equipment shall be isolated, insulated, or effectively grounded.

(4) 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.

(5) During stringing operations, 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.

(i) The grounds shall be left in place until conductor installation is completed.

(ii) Such grounds shall be removed as the last phase of aerial cleanup.

(iii) Except for moving type grounds, the grounds shall be placed and removed with a hot stick.

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

(7) 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. It is recommended that splicing be carried out on either an insulated platform or on a conductive metallic grounding mat bonded to both grounds. When a grounding mat is used, it is recommended that the grounding mat be roped off and an insulated walkway provided for access to the mat.

(8)(i) All conductors, subconductors, and overhead ground conductors shall be bonded to the tower at any isolated tower where it may be necessary to complete work on the transmission line.

(ii) Work on dead-end towers shall require grounding on all deenergized lines.

(iii) Grounds may be removed as soon as the work is completed: PROVIDED, That the line is not left open circuited at the isolated tower at which work is being completed.

(9) When performing work from the structures, clipping crews and all others working on conductors, subconductors, or overhead ground contractors shall be protected by individual grounds installed at every work location.

(e) LIVE-LINE BARE-HAND WORK. In addition to any other applicable standards contained elsewhere in this subpart all live-line bare-hand work shall be performed in accordance with the following requirements:

(1) Employees shall be instructed and trained in the live-line bare-hand technique and the safety requirements pertinent thereto before being permitted to use the technique on energized circuits.

(2) Before using the live-line bare-hand technique on energized high-voltage conductors or parts, a check shall be made of:

(i) The voltage rating of the circuit on which the work is to be performed;

(ii) The clearances to ground of lines and other energized parts on which work is to be performed;

and

(iii) The voltage limitations of the aerial-lift equipment intended to be used.

(3) Only equipment designed, tested, and intended for live-line bare-hand work shall be used.

(4) All work shall be personally supervised by a person trained and qualified to perform live-line bare-hand work.

(5) The automatic reclosing feature of circuit interrupting devices shall be made inoperative where practical before working on any energized line or equipment.

(6) Work shall not be performed during the progress of an electrical storm in the immediate vicinity.

(7) A conductive bucket liner or other suitable conductive device shall be provided for bonding the insulated aerial device to the energized line or equipment.

(i) The employee shall be connected to the bucket liner by use of conductive shoes, leg clips, or other suitable means.

(ii) Where necessary, adequate electrostatic shielding for the voltage being worked or conductive clothing shall be provided.

(8) Only tools and equipment intended for live-line bare-hand work shall be used, and such tools and equipment shall be kept clean and dry.

(9) Before the boom is elevated, the outriggers on the aerial truck shall be extended and adjusted to stabilize the truck and the body of the truck shall be bonded to an effective ground, or barricaded and considered as energized equipment.

(10) Before moving the aerial lift into the work position, all controls (ground level and bucket) shall be checked and tested to determine that they are in proper working condition.

(11) Arm current tests shall be made before starting work each day, each time during the day when higher voltage is going to be worked and when changed conditions indicate a need for additional tests. Aerial buckets used for bare-hand live-line work shall be subjected to an arm current test. This test shall consist of placing the bucket in contact with an energized source equal to the voltage to be worked upon for a minimum time of three (3) minutes. The leakage current shall not exceed 1 microampere per kilo-volt of nominal line-to-line voltage. Work operations shall be suspended immediately upon any indication of a malfunction in the equipment.

(12) All aerial lifts to be used for live-line bare-hand work shall have dual controls (lower and upper) as required by paragraph (e)(12)(i) and (ii) of this section.

(i) The upper controls shall be within easy reach of the employee in the basket. If a two basket type lift is used access to the controls shall be within easy reach from either basket.

(ii) The lower set of controls shall be located near base of the boom that will permit over-ride operation of equipment at any time.

(13) Ground level lift control shall not be operated unless permission has been obtained from the employee in lift, except in case of emergency.

(14) Before the employee contacts the energized part to be worked on, the conductive bucket liner shall be bonded to the energized conductor by means of a positive connection which shall remain attached to the energized conductor until the work on the energized circuit is completed.

(15) The minimum clearance distances for live-line bare-hand work shall be as specified in Table V-2. These minimum clearance distances shall be maintained from all grounded objects and from lines and equipment at a different potential than that to which the insulated aerial device is bonded unless such grounded objects or other lines and equipment are covered by insulated guards. These distances shall be maintained when approaching, leaving, and when bonded to the energized circuit.

TABLE V-2-MINIMUM CLEARANCE DISTANCES FOR LIVE-LINE BARE-HAND WORK (ALTERNATING CURRENT)

Voltage range (phase-to-phase) kilovolts	Distance in feet and inches for maximum voltage	
	Phase to ground	Phase to phase
2.1 to 15	2'0"	2'0"
15.1 to 35	2'4"	2'4"
35.1 to 46	2'6"	2'6"
46.1 to 72.5	3'0"	3'0"
72.6 to 121	3'4"	4'6"
138 to 145	3'6"	5'0"
161 to 169	3'8"	5'6"
230 to 242	5'0"	8'4"
345 to 362	¹ 7'0"	¹ 13'4"
500 to 552	¹ 11'0"	¹ 20'0"
700 to 765	¹ 15'0"	¹ 31'0"

¹For 345-362kv., 500-552kv., and 700-765kv., the minimum clearance distance may be reduced provided the distances are not made less than the shortest distance between the energized part and a grounded surface.

(16) When approaching, leaving, or bonding to an energized circuit the minimum distances in Table V-2 shall be maintained between all parts of the insulated boom assembly and any grounded parts (including the lower arm or portions of the truck).

(17) When positioning the bucket alongside an energized bushing or insulator string, the minimum line-to-ground clearances of Table V-2 must be maintained between all parts of the bucket and the grounded end of the bushing or insulator string.

(18)(i) The use of handlines between buckets, booms, and the ground is prohibited.

(ii) No conductive materials over 36 inches long shall be placed in the bucket, except for appropriate length jumpers, armor rods, and tools.

(iii) Nonconductive-type handlines may be used from line to ground when not supported from the bucket.

(19) The bucket and upper insulated boom shall not be overstressed by attempting to lift or support weights in excess of the manufacturer's rating.

(20)(i) A minimum clearance table (as shown in table V-2) shall be printed on a plate of durable nonconductive material, and mounted in the buckets or its vicinity so as to be visible to the operator of the boom.

(ii) It is recommended that insulated measuring sticks be used to verify clearance distances.

§1926.956 UNDERGROUND LINES.

(a) GUARDING AND VENTILATING STREET OPENING USED FOR ACCESS TO UNDERGROUND LINES OR EQUIPMENT. (1) Appropriate warning signs shall be promptly placed when covers of manholes, handholes, or vaults are removed. What is an appropriate warning sign is dependent upon the nature and location of the hazards involved.

(2) Before an employee enters a street opening, such as a manhole or an unvented vault, it shall be promptly protected with a barrier, temporary cover, or other suitable guard.

(3) When work is to be performed in a manhole or unvented vault:

- (i) No entry shall be permitted unless forced ventilation is provided or the atmosphere is found to be safe by testing for oxygen deficiency and the presence of explosive gases or fumes;
- (ii) Where unsafe conditions are detected, by testing or other means, the work area shall be ventilated and otherwise made safe before entry;
- (iii) Provisions shall be made for an adequate continuous supply of air.
- (b) WORK IN MANHOLES. (1) While work is being performed in manholes, an employee shall be available in the immediate vicinity to render emergency assistance as may be required. This shall not preclude the employee in the immediate vicinity from occasionally entering a manhole to provide assistance, other than emergency. This requirement does not preclude a qualified employee, working alone, from entering for brief periods of time, a manhole where energized cables or equipment are in service, for the purpose of inspection, housekeeping, taking readings, or similar work if such work can be performed safely.
 - (2) When open flames must be used or smoking is permitted in manholes, extra precautions shall be taken to provide adequate ventilation.
 - (3) Before using open flames in a manhole or excavation in an area where combustible gases or liquids may be present, such as near a gasoline service station, the atmosphere of the manhole or excavation shall be tested and found safe or cleared of the combustible gases or liquids.
- (c) TRENCHING AND EXCAVATING. (1) During excavation or trenching, in order to prevent the exposure of employees to the hazards created by damage to dangerous underground facilities, efforts shall be made to determine the location of such facilities and work conducted in a manner designed to avoid damage.
 - (2) Trenching and excavation operations shall comply with §§1926.651 and 1926.652.
 - (3) When underground facilities are exposed (electric, gas, water, telephone, etc.) they shall be protected as necessary to avoid damage.
 - (4) Where multiple cables exist in an excavation, cables other than the one being worked on shall be protected as necessary.
 - (5) When multiple cables exist in an excavation, the cable to be worked on shall be identified by electrical means unless its identity is obvious by reason of distinctive appearance.
 - (6) Before cutting into a cable or opening a splice, the cable shall be identified and verified to be the proper cable.
 - (7) When working on buried cable or on cable in manholes, metallic sheath continuity shall be maintained by bonding across the opening or by equivalent means.

§1926.957 Construction in energized substations.

- (A) WORK NEAR ENERGIZED EQUIPMENT FACILITIES. (1) When construction work is performed in an energized substation, authorization shall be obtained from the designated, authorized person before work is started.
 - (2) When work is to be done in an energized substation, the following shall be determined:
 - (i) What facilities are energized, and
 - (ii) What protective equipment and precautions are necessary for the safety of personnel.
 - (3) Extraordinary caution shall be exercised in the handling of busbars, tower steel, materials, and equipment in the vicinity of energized facilities. The requirements set forth in §1926.950(c), shall be complied with.
- (b) DEENERGIZED EQUIPMENT OR LINES. When it is necessary to deenergize equipment or lines for protection of employees, the requirements of §1926.950(d) shall be complied with.
- (c) BARRICADES AND BARRIERS. (1) Barricades or barriers shall be installed to prevent accidental contact with energized lines or equipment.
 - (2) Where appropriate, signs indicating the hazard shall be posted near the barricade or barrier. These signs shall comply with §1926.200.
- (d) CONTROL PANELS. (1) Work on or adjacent to energized control panels shall be performed by designated employees.
 - (2) Precaution shall be taken to prevent accidental operation of relays or other protective devices due to jarring, vibration, or improper wiring.
- (e) 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) All mobile cranes and derricks shall be effectively grounded when being moved or operated in close proximity to energized lines or equipment, or the equipment shall be considered energized.

(3) Fenders shall not be required for lowboys used for transporting large electrical equipment, transformers, or breakers.

(f) STORAGE. The storage requirements of §1926.953(c) shall be complied with.

(g) SUBSTATION FENCES. (1) When a substation fence must be expanded or removed for construction purposes, a temporary fence affording similar protection when the site is unattended, shall be provided. Adequate interconnection with ground shall be maintained between temporary fence and permanent fence.

(2) All gates to all unattended substations shall be locked, except when work is in progress.

(h) FOOTING EXCAVATION. (1) Excavation for auger, pad and piling type footings for structures and towers shall require the same precautions as for metal tower construction (see §1926.955(b)(1)).

(2) No employee shall be permitted to enter an unsupported auger-type excavation in unstable material for any purpose. Necessary clean-out in such cases shall be accomplished without entry.

§1926.958 EXTERNAL LOAD HELICOPTERS.

In all operations performed using a rotorcraft for moving or placing external loads, the provisions of §1926.551 of Subpart N of this part shall be complied with.

§1926.959 LINEMAN'S BODY BELTS, SAFETY STRAPS, AND LANYARDS.

(a) GENERAL REQUIREMENTS. The requirements of paragraphs (a) and (b) of this section shall be complied with for all lineman's body belts, safety straps and lanyards acquired for use after the effective date of this subpart.

(1) Hardware for lineman's body belts, safety straps, and lanyards shall be drop forged or pressed steel and have a corrosive resistive finish tested to American Society for Testing and Materials B117-64 (50-hour test). Surfaces shall be smooth and free of sharp edges.

(2) All buckles shall withstand a 2,000-pound tensile test with a maximum permanent deformation no greater than one sixty-fourth inch.

(3) D rings shall withstand a 5,000-pound tensile test without failure. Failure of a D ring shall be considered cracking or breaking.

(4) Snaphooks shall withstand a 5,000-pound tensile test without failure. Failure of a snaphook shall be distortion sufficient to release the keeper.

(b) SPECIFIC REQUIREMENTS. (1)(i) All fabric used for safety straps shall withstand an A.C. dielectric test of not less than 25,000 volts per foot "dry" for 3 minutes, without visible deterioration.

(ii) All fabric and leather used shall be tested for leakage current and shall not exceed 1 milliampere when a potential of 3,000 volts is applied to the electrodes positioned 12 inches apart.

(iii) Direct current tests may be permitted in lieu of alternating current tests.

(2) The cushion part of the body belt shall:

(i) Contain no exposed rivets on the inside;

(ii) Be at least three (3) inches in width;

(iii) Be at least five thirty-seconds (5/32) inch thick, if made of leather; and

(iv) Have pocket tabs that extended at least 1 1/2 inches down and three (3) inches back of the inside of circle of each D ring for riveting on plier or tool pockets. On shifting D belts, this measurement for pocket tabs shall be taken when the D ring section is centered.

(3) A maximum of four (4) tool loops shall be so situated on the body belt that four (4) inches of the body belt in the center of the back, measuring from D ring to D ring, shall be free of tool loops, and any other attachments.

(4) Suitable copper, steel, or equivalent liners shall be used around bar of D rings to prevent wear

between these members and the leather or fabric enclosing them.

(5) All stitching shall be of a minimum 42-pound weight nylon or equivalent thread and shall be lock stitched. Stitching parallel to an edge shall not be less than three-sixteenths (3/16) inch from edge of narrowest member caught by the thread. The use of cross stitching on leather is prohibited.

(6) The keeper of snaphooks shall have a spring tension that will not allow the keeper to begin to open with a weight of 2 1/2 pounds or less, but the keeper of snaphooks shall begin to open with a weight of four (4) pounds, when the weight is supported on the keeper against the end of the nose.

(7) Testing of lineman's safety straps, body belts and lanyards shall be in accordance with the following procedure:

(i) Attach one end of the safety strap or lanyard to a rigid support, the other end shall be attached to a 250-pound canvas bag of sand:

(ii) Allow the 250-pound canvas bag of sand to free fall 4 feet for (safety strap test) and 6 feet for (lanyard test); in each case stopping the fall of the 250-pound bag:

(iii) Failure of the strap or lanyard shall be indicated by any breakage, or slippage sufficient to permit the bag to fall free of the strap or lanyard. The entire "body belt assembly" shall be tested using one D ring. A safety strap or lanyard shall be used that is capable of passing the "impact loading test" and attached as required in paragraph (b)(7)(i) of this section. The body belt shall be secured to the 250-pound bag of sand at a point to simulate the waist of a man and allowed to drop as stated in paragraph (b)(7)(ii) of this section. Failure of the body belt shall be indicated by any breakage, or slippage sufficient to permit the bag to fall free of the body belt.

§1926.960 DEFINITIONS APPLICABLE TO THIS SUBPART.

(a) **ALIVE OR LIVE (ENERGIZED).** The term means electrically connected to a source of potential difference, or electrically charged so as to have a potential significantly different from that of the earth in the vicinity. The term "live" is sometimes used in place of the term "current-carrying", where the intent is clear, to avoid repetition of the longer term.

(b) **AUTOMATIC CIRCUIT RECLOSER.** The term means a self-controlled device for automatically interrupting and reclosing an alternating current circuit with a predetermined sequence of opening and reclosing followed by resetting, hold closed, or lockout operation.

(c) **BARRIER.** The term means a physical obstruction which is intended to prevent contact with energized lines or equipment.

(d) **BARRICADE.** The term means a physical obstruction such as tapes, screens, or cones intended to warn and limit access to a hazardous area.

(e) **BOND.** The term means an electrical connection from one conductive element to another for the purpose of minimizing potential differences or providing suitable conductivity for fault current or for mitigation of leakage current and electrolytic action.

(f) **BUSHING.** The term means an insulating structure including a through conductor, or providing a passageway for such a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

(g) **CABLE.** The term means a conductor with insulation, or a stranded conductor with or without insulation and other coverings (single-conductor cable) or a combination of conductors insulated from one another (multiple-conductor cable).

(h) **CABLE SHEATH.** The term means a protective covering applied to cables.

NOTE: A cable sheath may consist of multiple layers of which one or more is conductive.

(i) **CIRCUIT.** The term means a conductor or system of conductors through which an electric current is intended to flow.

(j) **COMMUNICATION LINES.** The term means the conductors and their supporting or containing structures which are used for public or private signal or communication service, and which operate at potentials not exceeding 400 volts or ground or 750 volts between any two points of the circuit, and the

transmitted power of which does not exceed 150 watts. When operating at less than 150 volts no limit is placed on the capacity of the system.

NOTE: Telephone, telegraph, railroad signal, data, clock, fire, police-alarm, community television antenna, and other systems conforming with the above are included. Lines used for signaling purposes, but not included under the above definition, are considered as supply lines of the same voltage and are to be so run.

(k) CONDUCTOR. The term means a material, usually in the form of a wire, cable, or bus bar suitable for carrying an electric current.

(l) CONDUCTOR SHIELDING. The term means an envelope which encloses the conductor of a cable and provides an equipotential surface in contact with the cable insulation.

(m) CURRENT-CARRYING PART. The term means a conducting part intended to be connected in an electric circuit to a source of voltage. Non-current-carrying parts are those not intended to be so connected.

(n) DEAD (DEENERGIZED). The term means free from any electrical connection to a source of potential difference and from electrical charges: Not having a potential difference from that of earth.

NOTE: The term is used only with reference to current-carrying parts which are sometimes alive (energized).

(o) DESIGNATED EMPLOYEE. The term means a qualified person delegated to perform specific duties under the conditions existing.

(p) EFFECTIVELY GROUNDED. The term means intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to prevent the buildup of voltages which may result in undue hazard to connected equipment or to persons.

(q) ELECTRIC LINE TRUCKS. The term means a truck used to transport men, tools, and material, and to serve as a traveling workshop for electric power line construction and maintenance work. It is sometimes equipped with a boom and auxiliary equipment for setting poles, digging holes, and elevating material or men.

(r) ENCLOSED. The term means surrounded by a case, cage, or fence, which will protect the contained equipment and prevent accidental contact of a person with live parts.

(s) EQUIPMENT. This is a general term which includes fittings, devices, appliances, fixtures, apparatus, and the like, used as part of, or in connection with, an electrical power transmission and distribution system, or communication systems.

(t) EXPOSED. The term means not isolated or guarded.

(u) ELECTRIC SUPPLY LINES. The term means those conductors used to transmit electric energy and their necessary supporting or containing structures. Signal lines of more than 400 volts to ground are always supply lines within the meaning of the rules, and those of less than 400 volts to ground may be considered as supply lines, if so run and operated throughout.

(v) GUARDED. The term means protected by personnel, covered, fenced, or enclosed by means of suitable casings, barrier rails, screens, mats, platforms, or other suitable devices in accordance with standard barricading techniques designed to prevent dangerous approach or contact by persons or objects.

NOTE: Wires, which are insulated but not otherwise protected, are not considered as guarded.

(w) GROUND. (REFERENCE). The term means that conductive body, usually earth, to which an electric potential is referenced.

(x) GROUND (AS A NOUN). The term means a conductive connection whether intentional or accidental, by which an electric circuit or equipment is connected to reference ground.

(y) GROUND (AS A VERB). The term means the connecting or establishment of a connection, whether by intention or accident of an electric circuit or equipment to reference ground.

(z) GROUNDING ELECTRODE (GROUND ELECTRODE). The term grounding electrode means a conductor embedded in the earth, used for maintaining ground potential on conductors connected to it, and

for dissipating into the earth current conducted to it.

(aa) GROUNDING ELECTRODE RESISTANCE. The term means the resistance of the grounding electrode to earth.

(bb) GROUNDING ELECTRODE CONDUCTOR (GROUNDING CONDUCTOR). The term means a conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode.

(cc) GROUNDED CONDUCTOR. The term means a system or circuit conductor which is intentionally grounded.

(dd) GROUNDED SYSTEM. The term means a system of conductors in which at least one conductor or point (usually the middle wire, or neutral point of transformer or generator windings) is intentionally grounded, either solidly or through a current-limiting device (not a current-interrupting device).

(ee) HOTLINE TOOLS AND ROPES. The term means those tools and ropes which are especially designed for work on energized high voltage lines and equipment. Insulated aerial equipment especially designed for work on energized high voltage lines and equipment shall be considered hot line.

(ff) INSULATED. The term means separated from other conducting surfaces by a dielectric substance (including air space) offering a high resistance to the passage of current.

NOTE: When any object is said to be insulated, it is understood to be insulated in suitable manner for the conditions to which it is subjected. Otherwise, it is within the purpose of this subpart, uninsulated. Insulating covering of conductors is one means of making the conductor insulated.

(gg) INSULATION (AS APPLIED TO CABLE). The term means that which is relied upon to insulate the conductor from other conductors or conducting parts or from ground.

(hh) INSULATION SHIELDING. The term means an envelope which encloses the insulation of a cable and provides an equipotential surface in contact with cable insulation.

(ii) ISOLATED. The term means an object that is not readily accessible to persons unless special means of access are used.

(jj) MANHOLE. The term means a sub-surface enclosure which personnel may enter and which is used for the purpose of installing, operating, and maintaining equipment and/or cable.

(kk) PULLING TENSION. The term means the longitudinal force exerted on a cable during installation.

- (ll) **QUALIFIED PERSON.** The term means a person who by reason of experience or training is familiar with the operation to be performed and the hazards involved.
- (mm) **SWITCH.** The term means a device for opening and closing or changing the connection of a circuit. In these rules, a switch is understood to be manually operable, unless otherwise stated.
- (nn) **TAG.** The term means a system or method of identifying circuits, systems or equipment for the purpose of alerting persons that the circuit, system or equipment is being worked on.
- (oo) **UNSTABLE MATERIAL.** The term means earth material, other than running, that because of its nature or the influence of related conditions, cannot be depended upon to remain in place without extra support, such as would be furnished by a system of shoring.
- (pp) **VAULT.** The term means an enclosure above or below ground which personnel may enter and is used for the purpose of installing, operating, and/or maintaining equipment and/or cable.
- (qq) **VOLTAGE.** The term means the effective (rms) potential difference between any two conductors or between a conductor and ground. Voltages are expressed in nominal values. The nominal voltage of a system or circuit is the value assigned to a system or circuit of a given voltage class for the purpose of convenient designation. The operating voltage of the system may vary above or below this value.
- (rr) **VOLTAGE OF AN EFFECTIVELY GROUNDED CIRCUIT.** The term means the voltage between any conductor and ground unless otherwise indicated.
- (ss) **VOLTAGE OF A CIRCUIT NOT EFFECTIVELY GROUNDED.** The term means the voltage between any two conductors. If one circuit is directly connected to and supplied from another circuit of higher voltage (as in the case of an autotransformer), both are considered as of the higher voltage, unless the circuit of lower voltage is effectively grounded, in which case its voltage is not determined by the circuit of higher voltage. Direct connection implies electric connection as distinguished from connection merely through electromagnetic or electrostatic induction.

**APPENDIX C TO CODE 11 -
29 C.F.R. §1910.137 ELECTRICAL PROTECTIVE EQUIPMENT**

- (a) **DESIGN REQUIREMENTS.** Insulating blankets, matting, covers, line hose, gloves, and sleeves made of rubber shall meet the following requirements:
 - (1) **MANUFACTURE AND MARKING.** (i) Blankets, gloves, and sleeves shall be produced by a seamless process.
 - (ii) Each item shall be clearly marked as follows:
 - (A) Class 0 equipment shall be marked Class 0.
 - (B) Class 1 equipment shall be marked Class 1.
 - (C) Class 2 equipment shall be marked Class 2.
 - (D) Class 3 equipment shall be marked Class 3.
 - (E) Class 4 equipment shall be marked Class 4.
 - (F) Non-ozone-resistant equipment other than matting shall be marked Type I.
 - (G) Ozone-resistant equipment other than matting shall be marked Type II.
 - (H) Other relevant markings, such as the manufacturer's identification and the size of the equipment, may also be provided.
 - (iii) Markings shall be nonconducting and shall be applied in such a manner as not to impair the insulating qualities of the equipment.
 - (iv) Markings on gloves shall be confined to the cuff portion of the glove.
 - (2) **ELECTRICAL REQUIREMENTS.** (i) Equipment shall be capable of withstanding the a-c proof-test voltage specified in Table I-2 or the d-c proof-test voltage specified in Table I-3.
 - (A) The proof test shall reliably indicate that the equipment can withstand the voltage involved.
 - (B) The test voltage shall be applied continuously for 3 minutes for equipment other than matting and shall be applied continuously for 1 minute for matting.
 - (C) Gloves shall also be capable of withstanding the a-c proof-test voltage specified in Table I-2 after a 16-hour water soak. (See the note following paragraph (a)(3)(ii)(B) of this section.)

- (ii) When the a-c proof test is used on gloves, the 60-hertz proof-test current may not exceed the values specified in Table I-2 at any time during the test period.
 - (A) If the a-c proof test is made at a frequency other than 60 hertz, the permissible proof-test current shall be computed from the direct ratio of the frequencies.
 - (B) For the test, gloves (right side out) shall be filled with tap water and immersed in water to a depth that is in accordance with Table I-4. Water shall be added to or removed from the glove, as necessary, so that the water level is the same inside and outside the glove.
 - (C) After the 16-hour water soak specified in paragraph (a)(2)(i)(C) of this section, the 60-hertz proof-test current may exceed the values given in Table I-2 by not more than 2 milliamperes.
- (iii) Equipment that has been subjected to a minimum breakdown voltage test may not be used for electrical protection. (See the note following paragraph (a)(3)(ii)(B) of this section.)
- (iv) Material used for Type II insulating equipment shall be capable of withstanding an ozone test, with no visible effects. The ozone test shall reliably indicate that the material will resist ozone exposure in actual use. Any visible signs of ozone deterioration of the material, such as checking, cracking, breaks, or pitting, is evidence of failure to meet the requirements for ozone-resistant material. (See the note following paragraph (a)(3)(ii)(B) of this section.)
- (3) WORKMANSHIP AND FINISH. (i) Equipment shall be free of harmful physical irregularities that can be detected by the tests or inspections required under this section.
 - (ii) Surface irregularities that may be present on all rubber goods because of imperfections on forms or molds or because of inherent difficulties in the manufacturing process and that may appear as indentations, protuberances, or imbedded foreign material are acceptable under the following conditions:
 - (A) The indentation or protuberance blends into a smooth slope when the material is stretched.
 - (B) Foreign material remains in place when the insulating material is folded and stretches with the insulating material surrounding it.

NOTE: Rubber insulating equipment meeting the following national consensus standards is deemed to be in compliance with paragraph (a) of this section:

American Society for Testing and Materials (ASTM) D 120-87, Specification for Rubber Insulating Gloves.

ASTM D 178-88, Specification for Rubber Insulating Matting.

ASTM D 1048-88a, Specification for Rubber Insulating Blankets.

ASTM D 1049-88, Specification for Rubber Insulating Covers.

ASTM D 1050-90, Specification for Rubber Insulating Line Hose.

ASTM D 1051-87, Specification for Rubber Insulating Sleeves.

These standards contain specifications for conducting the various tests required in paragraph (a) of this section. For example, the a-c and d-c proof tests, the breakdown test, the water soak procedure, and the ozone test mentioned in this paragraph are described in detail in the ASTM standards.

- (b) IN-SERVICE CARE AND USE. (1) Electrical protective equipment shall be maintained in a safe, reliable condition.
 - (2) The following specific requirements apply to insulating blankets, covers, line hose, gloves, and sleeves made of rubber:
 - (i) Maximum use voltages shall conform to those listed in Table I-5.
 - (ii) Insulating equipment shall be inspected for damage before each day's use and immediately following any incident that can reasonably be suspected of having caused damage. Insulating gloves shall be given an air test, along with the inspection.
 - (iii) Insulating equipment with any of the following defects may not be used:
 - (A) A hole, tear, puncture, or cut;
 - (B) Ozone cutting or ozone checking (the cutting action produced by ozone on rubber under mechanical stress into a series of interlacing cracks);
 - (C) An embedded foreign object;
 - (D) Any of the following texture changes: swelling, softening, hardening, or becoming sticky or inelastic.
 - (E) Any other defect that damages the insulating properties.
 - (iv) Insulating equipment found to have other defects that might affect its insulating properties

shall be removed from service and returned for testing under paragraphs (b)(2)(viii) and (b)(2)(ix) of this section.

- (v) Insulating equipment shall be cleaned as needed to remove foreign substances.
- (vi) Insulating equipment shall be stored in such a location and in such a manner as to protect it from light, temperature extremes, excessive humidity, ozone, and other injurious substances and conditions.
- (vii) Protector gloves shall be worn over insulating gloves, except as follows:
 - (A) Protector gloves need not be used with Class 0 gloves, under limited-use conditions, where small equipment and parts manipulation necessitate unusually high finger dexterity.

NOTE: Extra care is needed in the visual examination of the glove and in the avoidance of handling sharp objects

(B) Any other class of glove may be used for similar work without protector gloves if the employer can demonstrate that the possibility of physical damage to the gloves is small and if the class of glove is one class higher than that required for the voltage involved. Insulating gloves that have been used without protector gloves may not be used at a higher voltage until they have been tested under the provisions of paragraphs (b)(2)(viii) and (b)(2)(ix) of this section.

(viii) Electrical protective equipment shall be subjected to periodic electrical tests. Test voltages and the maximum intervals between tests shall be in accordance with Table I-5 and Table I-6.

(ix) The test method used under paragraphs (b)(2)(viii) and (b)(2)(ix) of this section shall reliably indicate whether the insulating equipment can withstand the voltages involved.

NOTE: Standard electrical test methods considered as meeting this requirement are given in the following national consensus standards:

American Society for Testing and Materials (ASTM) D 120-87, Specification for Rubber Insulating Gloves.

ASTM D 1048-88a, Specification for Rubber Insulating Blankets.

ASTM D 1049-88, Specification for Rubber Insulating Covers.

ASTM D 1050-90, Specification for Rubber Insulating Line Hose.

ASTM D 1051-87, Specification for Rubber Insulating Sleeves.

ASTM F 478-92, Specification for In-Service Care of Insulating Line Hose and Covers.

ASTM F 479-88a, Specification for In-Service Care of Insulating Blankets.

ASTM F 496-91, Specification for In-Service Care of Insulating Gloves and Sleeves.

(x) Insulating equipment failing to pass inspections or electrical tests may not be used by employees, except as follows:

(A) Rubber insulating line hose may be used in shorter lengths with the defective portion cut off.

(B) Rubber insulating blankets may be repaired using a compatible patch that results in physical and electrical properties equal to those of the blanket.

(C) Rubber insulating blankets may be salvaged by severing the defective area from the undamaged portion of the blanket. The resulting undamaged area may not be smaller than 22 inches by 22 inches (560 mm by 560 mm) for Class 1, 2, 3, and 4 blankets.

(D) Rubber insulating gloves and sleeves with minor physical defects, such as small cuts, tears, or punctures, may be repaired by the application of a compatible patch. Also, rubber insulating gloves and sleeves with minor surface blemishes may be repaired with a compatible liquid compound. The patched area shall have electrical and physical properties equal to those of the surrounding material. Repairs to gloves are permitted only in the area between the wrist and the reinforced edge of the opening.

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

(xii) The employer shall certify that equipment has been tested in accordance with the requirements of paragraphs (b)(2)(viii), (b)(2)(ix), and (b)(2)(xi) of this section. The certification shall identify the equipment that passed the test and the date it was tested.

NOTE: Marking of equipment and entering the results of the tests and the dates of testing onto logs are two acceptable means of meeting this requirement.

TABLE I - 2
A-C PROOF-TEST REQUIREMENTS

Class of Equipment	Proof-Test Voltage rms V	Maximum Proof-Test Current, mA (Gloves Only)			
		267-mm (10.5-in) in) Glove Glove	356-mm (14-in) Glove	406-mm (16-in) Glove	457-mm (18-
0	5,000	8	12	14	16
1	10,000		14	16	18
2	20,000		16	18	20
3	30,000		18	20	22
4	40,000			22	24

TABLE I - 3
D-C PROOF-TEST REQUIREMENTS

Class of Equipment	Proof-Test Voltage
0	20,000
1	40,000
2	50,000
3	60,000
4	70,000

NOTE: The d-c voltages listed in this table are not appropriate for proof testing rubber insulating line hose or covers. For this equipment, d-c proof tests shall use a voltage high enough to indicate that the equipment can be safely used at the voltages listed in Table I-4. See ASTM D 1050-90 and ASTM D 1049-88 for further information on proof tests for rubber insulating line hose and covers.

TABLE I - 4
GLOVE TESTS - WATER LEVEL^{1,2}

Class of Glove	AC Proof Test		DC Proof Test	
	mm.	in.	mm.	in.
0	38	1.5	38	1.5
1	38	1.5	51	2.0
2	64	2.5	76	3.0
3	89	3.5	102	4.0
4	127	5.0	153	6.0

¹The water level is given as the clearance from the cuff of the glove to the water line, with a tolerance of ± 13 mm. (± 0.5 in.).

²If atmospheric conditions make the specified clearances impractical, the clearances may be increased by a maximum of 24 mm. (1 in.).

TABLE I - 5
RUBBER INSULATING EQUIPMENT VOLTAGE REQUIREMENTS

Class of Equipment	Maximum Use Voltage ¹ a-c - rms	Retest Voltage ² a-c - rms	Retest Voltage ² d-c - avg
0	1,000	5,000	20,000
1	7,500	10,000	40,000
2	17,000	20,000	50,000
3	26,500	30,000	60,000
4	36,000	40,000	70,000

¹The maximum use voltage is the a-c voltage (rms) classification of the protective equipment that designates the maximum nominal design voltage of the energized system that may be safely worked. The nominal design voltage is equal to the phase-to-phase voltage on multiphase circuits. However, the phase-to-ground potential is considered to be the nominal design voltage:

(1) If there is no multiphase exposure in a system area and if the voltage exposure is limited to the phase-to-ground potential, or

(2) If the electrical equipment and devices are insulated or isolated or both so that the multiphase exposure on a grounded wye circuit is removed.

²The proof-test voltage shall be applied continuously for at least 1 minute, but no more than 3 minutes.

TABLE I - 6
RUBBER INSULATING EQUIPMENT TEST INTERVALS

Type of Equipment	When to Test
Rubber insulating line hose	Upon indication that insulating value is suspect
Rubber insulating covers	Upon indication that insulating value is suspect
Rubber insulating blankets	Before first issue and every 12 months thereafter ¹
Rubber insulating gloves	Before first issue and every 6 months thereafter ¹
Rubber insulating sleeves	Before first issue and every 12 months thereafter ¹

¹If the insulating equipment has been electrically tested but not issued for service, it may not be placed into service unless it has been electrically tested within the previous 12 months.

The information contained in this Appendix is a summary of the technical requirements of Safety Code 11. This summary is provided for convenience only and cannot be relied on in lieu of the actual safety standards.

APPENDIX D TO CODE 11 - SUMMARY OF 29 C.F.R. §1910.269 ELECTRIC POWER GENERATION, TRANSMISSION, AND DISTRIBUTION

(a) Application.

This section covers the operation and maintenance (repair) of electric power generation, control, transformation, transmission, and distribution lines and equipment.

Employees shall be trained in safety related work practices. The employer must certify that each employee has received their training.

(b) Medical services and first aid. G95

A suitable number of employees need to be trained in first aid and CPR when work is being performed on energized lines of 50 volts or more.

(c) Job briefing.

Job briefing will be conducted before the start of each job and before any significant changes occur during the job.

(d) Hazardous energy control.

A lockout-tagout program must be developed and implemented by the company. All affected employees must be trained on these procedures and the employer must certify this training.

(e) Enclosed spaces.

The employer must ensure the use of safe work practices during all enclosed space entries. All affected employees must be trained in enclosed space entry.

(f) Excavations.

A competent person must be in charge of all excavation work to insure safety for employees.

(g) Personal protective equipment (PPE).

PPE must be suitable for the task to be performed. The employer must perform an evaluation of each employee's job and provide adequate PPE.

(h) Ladders and platforms.

Ladders and platforms must be secured in place and not overloaded. Conductive ladders may not be used

near exposed energized lines except under special conditions.

(i) Hand and portable tools.

Cord and plug electrical equipment must be properly grounded or be of the double insulated type. All pneumatic and hydraulic tools shall be used in accordance with the manufacturer's instructions. Quick acting, self-closing connectors are recommended for attaching tools to air hoses.

(J) Live line tools.

Live line tools must be properly maintained to prevent contamination and maintain mechanical integrity of the tool.

(k) Materials storage and handling.

Construction or other type materials may not be stored in the area of exposed energized lines or equipment parts.

(1) Working on or near exposed energized parts.

Only qualified employees may work on or with exposed energized lines or parts of equipment. At least two qualified employees shall be present while the following types of work are performed:

1. Work on lines of 600 volts or more.
2. Work on deenergized lines if adjacent lines are more than 600 volts,
3. Work on transformers, capacitors or regulators when exposed to more than 600 volts,
4. Work involving the use of mechanical equipment that can be energized and when exposed to 600 volts or more.

Clothing made from acetate, nylon, polyester, or rayon is prohibited for use by employees exposed to flames or electric arcs. Suitable tools and PPE must be worn by employees when handling fuses.

(m) Deenergizing lines and equipment.

A system operator or a designated employee shall be in charge of clearance while a crew is energizing or deenergizing lines or equipment.

(n) Grounding for the protection of employees.

Before employees can work lines or equipment as deenergized, the provisions of 1910.269 (m)(3) must be followed. If the employer decides to not install ground sets, then additional requirements such as assuring that contact with other electrical sources is prevented and no induced voltage is possible. Before grounds are installed, all lines and equipment shall be tested for the presence of voltage.

(o) Testing.

Safe work practices shall be followed for high voltage and high power testing performed in laboratories, shops, substations, and in the field on electric transmission lines and equipment. Safety practices governing employee work at temporary or field test areas shall provide for a routine check of such test areas for safety at the beginning of each series of tests.

(p) Mechanical equipment.

All mechanical elevating and rotating equipment shall receive a thorough visual inspection before use on each shift. All vehicular equipment when operated in reverse shall be equipped with backup alarms or be directed by a signal person. All rubber tired equipment must be equipped with rollover protective structures. A designated employee other than the operator shall observe the approach distance of mechanical equipment to exposed, energized power lines and equipment. Mechanical equipment used to lift materials shall not be overloaded.

(q) Overhead lines.

All overhead work places shall be evaluated and determined as safe before work is started. All holes for poles or other excavations must be covered, guarded by a barrier or have an attendant to prevent employees from stepping or falling into the holes. Tension stringing methods, barriers or other equivalent measures must be used to protect employees from high voltage.

Ground sets must be used where necessary to protect employees or lines must be worked as if energized when installing or removing overhead lines. Before employees are allowed to perform live-line bare-hand work, they must be properly trained in live-line bare-hand handling techniques.

(r) Line-clearance tree trimming.

Before work is started on tree trimming operations an evaluation must be conducted to determine how the work can be performed safely. All employees performing tree trimming will be trained in the special hazards related to this type of work. Employees need training and a safe place to work from such as a platform with guardrails or a platform with a safety harness and lanyard when working with sprayers and related equipment.

All power saws shall be operated in a safe manner. All backpack power units shall be equipped with a quick shutoff switch readily accessible to the operator. Each employee shall be tied in with climbing rope and safety saddle when working in trees.

(s) Communication facilities.

Microwave antennas shall be located or arranged so employees cannot be injured by the transmission of microwaves. Radiation warning signs and hazard warning instructions shall be posted in prominent locations to warn employees of radiation hazards.

(t) Underground electrical.

A suitable ladder or other safe climbing device shall be used to enter or exit a manhole or subsurface vault. While work is being performed in a manhole where energized electric equipment is located, an attendant properly trained in first aid and CPR will be available at all times on the surface.

When multiple cables are present in subsurface vaults, the cable to be worked shall be identified by electrical means, unless its identity is obvious.

(u) Substations.

Sufficient access and working space shall be provided and maintained around electrical equipment. Conductive fences around substations shall be grounded. Guards need to be provided around all live electrical parts of more than 150 volts to ground that do not have an insulating covering. When guards are removed from energized equipment, barriers shall be installed to protect any employees that are not working

directly on the energized equipment.

(v) Power generation.

All interlocks and other safety devices shall be maintained in a safe and operable condition. Signs warning unqualified persons to keep out shall be displayed at entrances to rooms containing electric supply equipment. Entrances to rooms and spaces containing electric supply equipment that are not under the observation of an attendant shall be kept locked.

Eye protection or full face protection shall be worn when condenser, heater or boiler tubes are being cleaned. Areas where chemical cleaning of boilers or pressure vessels is in progress shall be cordoned off to restrict access and signs restricting entry and warning of hazards shall be posted. Chlorine system enclosures must be posted with warning signs. Signs shall warn employees of health as well as fire and explosion hazards.

(w) Special conditions.

Before employees work on capacitors, the capacitors shall be disconnected from energy sources and, after a wait of at least five minutes, proceed with caution to short circuit them.

Sufficient illumination needs to be provided to enable employees to work safely on electric lines or equipment.

Whenever employees are exposed to the hazard of drowning, they need to wear US Coast Guard approved flotation devices. An employee may cross streams or bodies of water only if safe passage is provided, such as a bridge.

Employees working in the vicinity of vehicular traffic need to be protected from danger by suitable traffic control signs or devices.

TABLE 1. ELECTRICAL SAFETY-RELATED WORK PRACTICES IN SECTION 1910.269

Compliance with subpart S is considered as compliance with §1910.269

(d) electric shock hazards only
 (h)(3)
 (i)(2)
 (k)
 (l)(1) thru (l)(4), (l)(6)(i), and (l)(8) thru (l)(10)
 (m)
 (p)(4)
 (s)(2)
 (u)(1) and (u)(3) thru (u)(5)
 (v)(3) through (v)(5)
 (w)(1) and (W)(7)

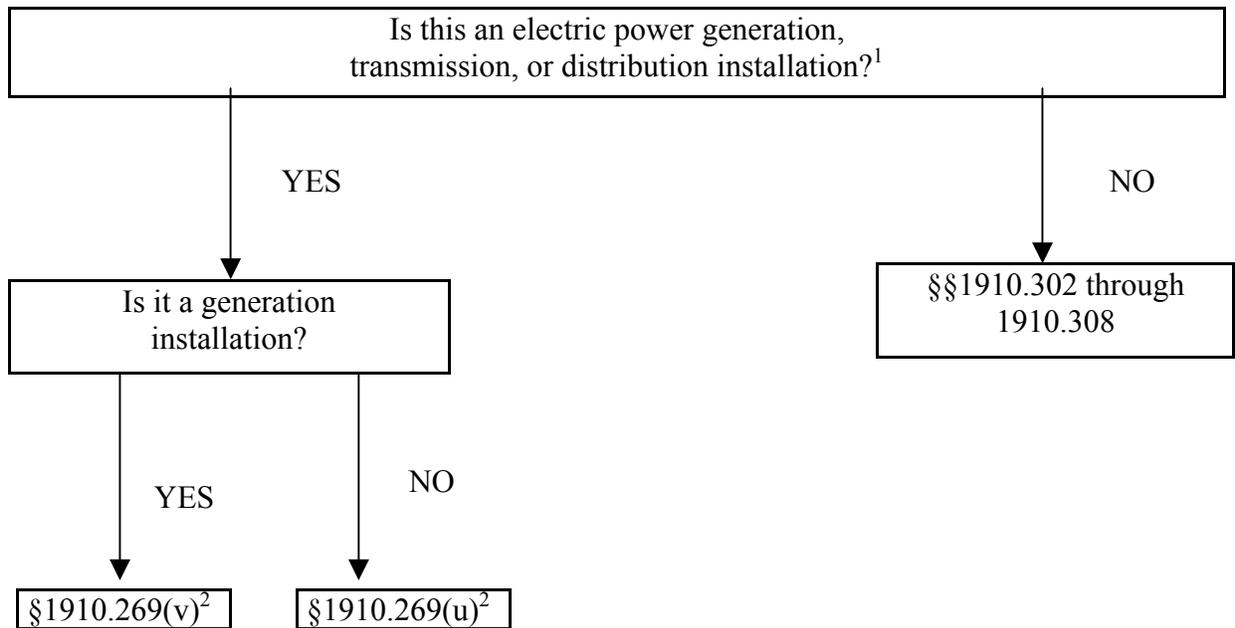
Paragraphs that apply regardless of compliance with subpart S

(a)(2)² and (a)(3)².
 (b)².
 (c)².
 (d), other than electric shock hazards.
 (e).
 (f).
 (g).
 (h)(l) and (h)(2).
 (i)(3)² and (i)(4)².
 (j)².
 (l)(5)², (l)(6)(iii)², and (l)(7)².
 (n)².
 (o)².
 (p)(1) through (p)(3).
 (q)².
 (r).
 (s)(1).
 (t)².
 (u)(2)² and (u)(6)².
 (v)(1), (v)(2)², and (v)(6) through (v)(12).
 (w)(2) through (w)(6)², (w)(8), and (w)(9)².

¹If the electrical installation meets the requirements of §§1910.332 through 1910.308 of this Part, then the electrical installation and any associated electrical safety-related work practices conforming to §§1910.332 through 1910.335 of this Part are considered to comply with these provisions of §1910.269 of this Part.

²These provisions include electrical safety requirements that must be met regardless of compliance with Subpart S of this Part.

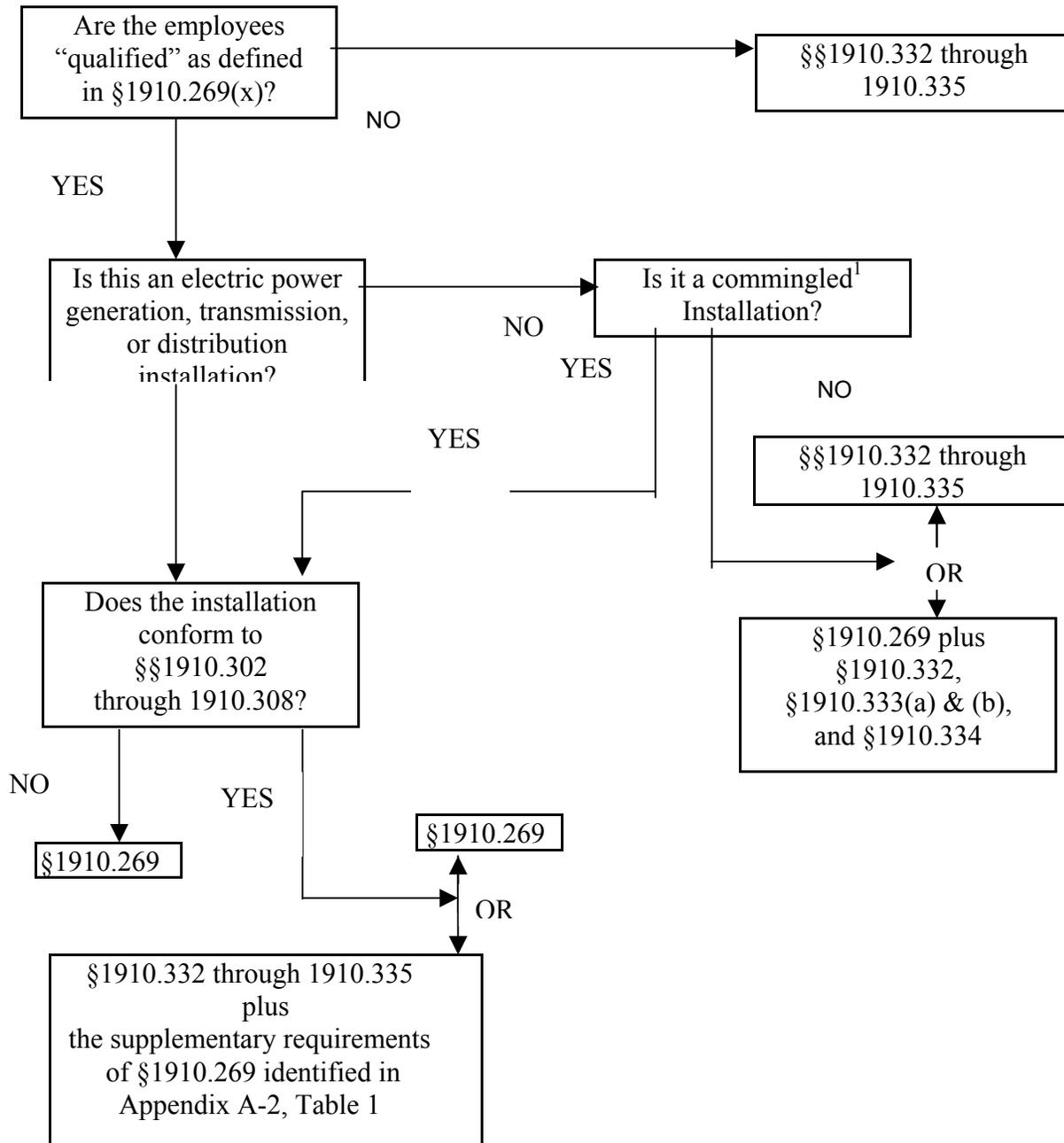
Appendix A-1 to Section 1910.269--Application of Section 1910.269 and Subpart S of this Part to Electrical Installations.



¹Electrical installation design requirements only. See Appendix A-2 of this section for electrical safety-related work practices. Supplementary electric generating equipment that is used to supply a workplace for emergency, standby, or similar purposes only is not considered to be an electric power generation installation.

²See Table 1 of Appendix A-2 of this section for requirements that can be met through compliance with subpart S of this part.

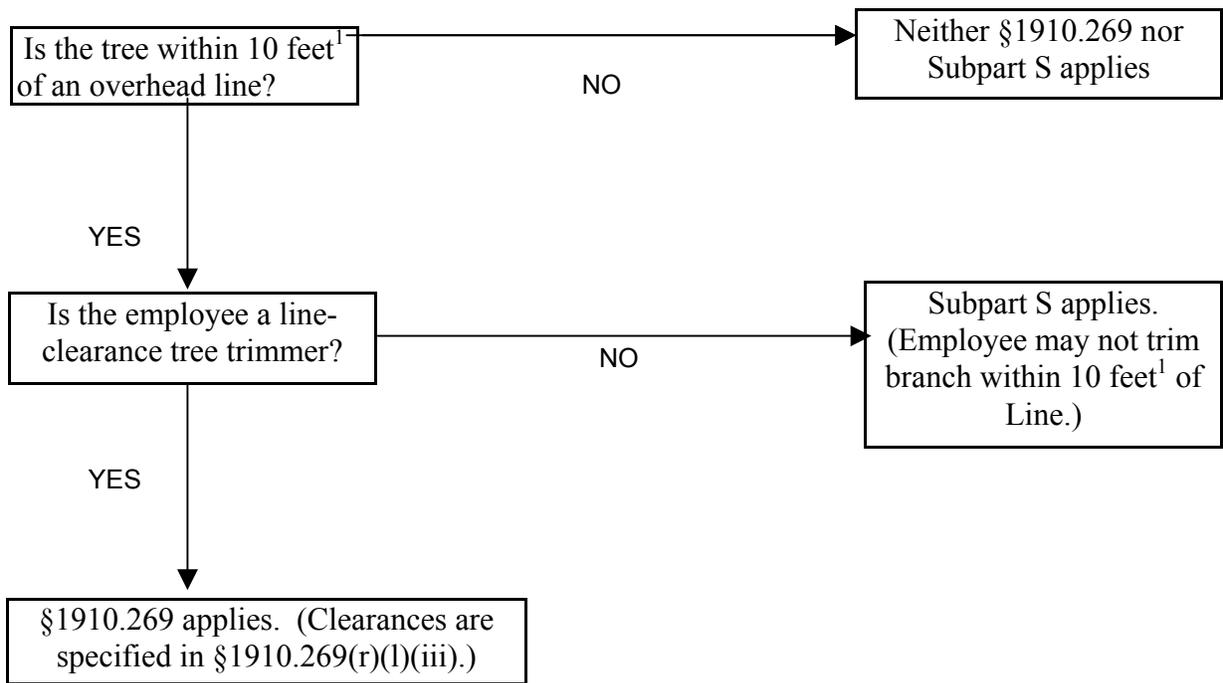
Appendix A-2 to Section 1910.269--Application of Section 1910.269 and Subpart S of this Part to Electrical Safety-Related Work Practices.



¹Commingled to the extent that the electric power generation, transmission, or distribution installation poses the greater hazard.

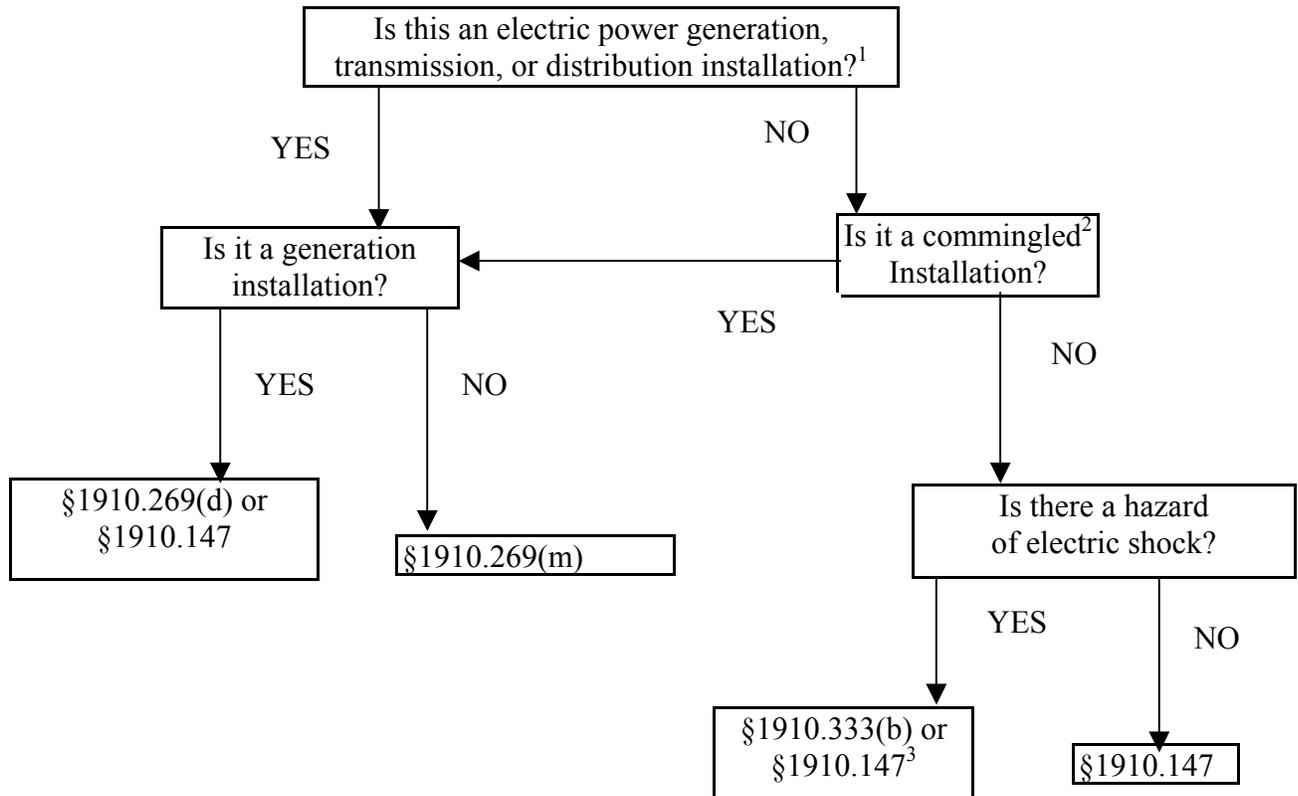
Appendix A-3 to Section 1910.269--Application of Section 1910.269 and Subpart S of

This Part to Tree-Trimming Operations.



¹10 feet plus 4 inches for every 10 kilovolts over 50 kilovolts.

Appendix A-4 to Section 1910.269--Application of Section 1910.147, Section 1910.269 and Section 1910.333 to Hazardous Energy Control Procedures (Lockout/Tagout).

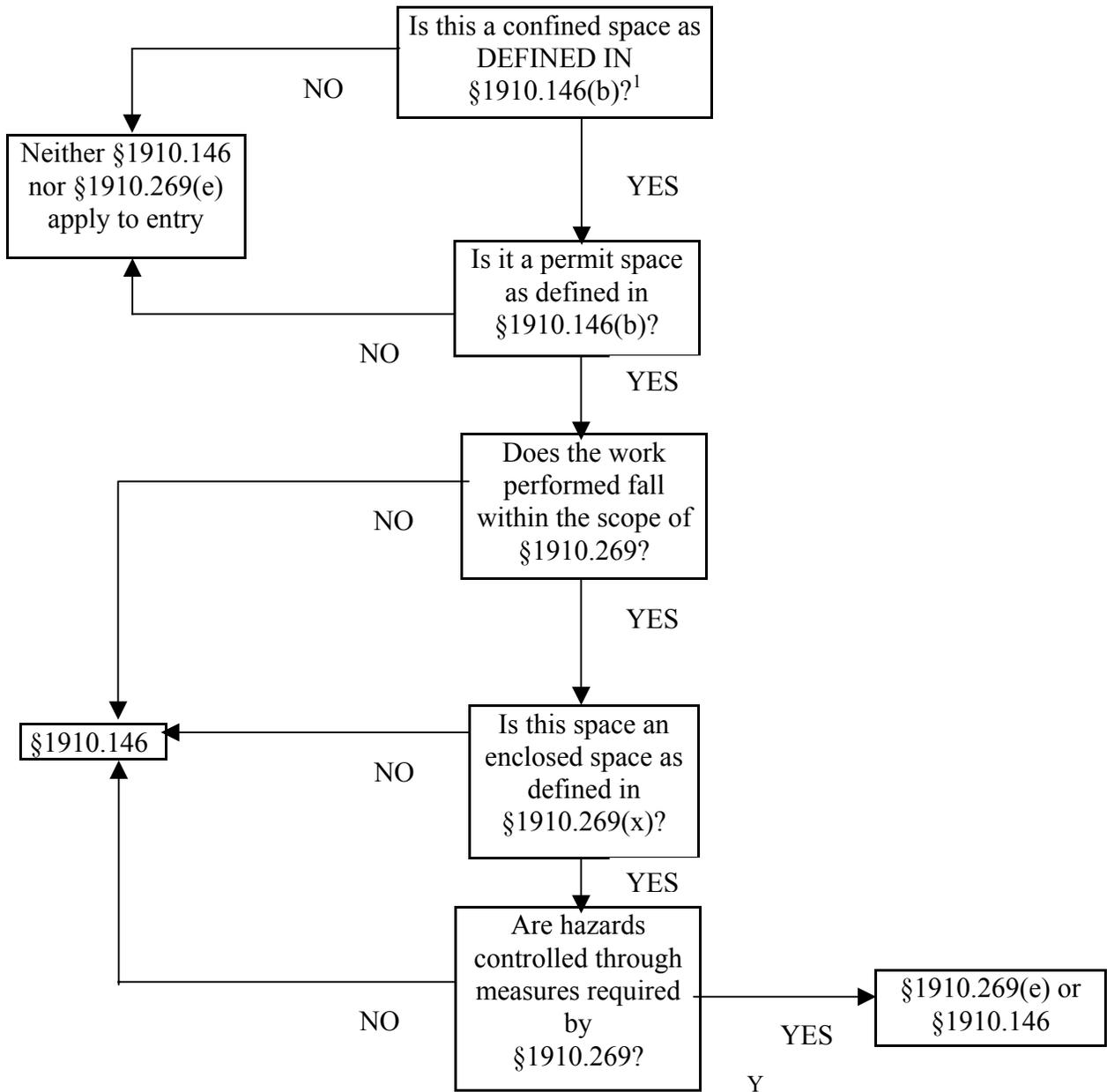


¹If the installation conforms to §§1910.303 through 1910.308 of this part, the lockout and tagging procedures of §1910.333(b) of this part may be followed for electric shock hazards.

²Commingled to the extent that the electric power generation, transmission, or distribution installation poses the greater hazard.

³Section 1910.333(b)(2)(iii)(D) and (b)(2)(iv)(B) of this part still apply.

Appendix A-5 to Section 1910.269--Application of Section 1910.146 and Section 1910.269 to Permit-Required Confined Spaces.



¹See §1910.146(c) for general non-entry requirements that apply to all confined spaces.

The information contained in this Appendix is a summary of the technical requirements of Safety Code 11. This summary is provided for convenience only and cannot be relied on in lieu of the actual safety standards.

**APPENDIX E TO CODE 11 - SUMMARY OF 29 C.F.R. §1926.950
CONSTRUCTION OF POWER TRANSMISSION, DISTRIBUTION
LINES AND EQUIPMENT**

1926.950 GENERAL REQUIREMENTS

(a) Application.

The term "construction" includes the erection of new electric transmission and distribution lines, equipment, the alteration, and conversion of such lines.

(b) Initial inspections, tests, or determinations.

An evaluation of existing conditions shall be made before starting work on any new construction.

(c) Clearances.

Employees must not work close to exposed energized parts unless proper PPE (Personal Protection Equipment) or insulated slicks are used or barriers are provided.

(d) Deenergizing lines and equipment.

When deenergizing lines or equipment in excess of 600 volts, and the means of disconnection is not visibly open or visibly locked out, the provisions of paragraphs (d)(1)(i) through (vii) of this section must be complied with.

Upon completion of work, the designated employee in charge shall report to the designated authority that all employees are in the clear, protective grounds have been removed, and that all tags may be removed.

(e) Emergency procedures and first aid.

The employer must provide training in first aid and procedures involving emergency situations.

(f) Night work.

Adequate lighting such as spotlights or portable lights must be provided so that work can be performed safely.

(g) Work near or over water.

Suitable protection equipment such as life preservers, safety nets, safety harness and lanyards, and standby rescue boats need to be provided.

(h) Sanitation facilities.

Portable sanitation facilities may be provided or employees need to be allowed to visit the nearest permanent facility.

(i) Hydraulic fluids.

All hydraulic fluids used for tools or other equipment that is used around energized equipment shall be the insulating type.

1926.951 TOOLS & PROTECTIVE EQUIPMENT

(a) Protective equipment.

Rubber protective equipment must be visibly inspected and air tested prior to each use.

Protective hats must be Class "B" for employees that are exposed to the hazards of falling objects, electric shock, or burns.

(b) Personal Climbing equipment.

Body belts and safety lanyards shall be worn by employees working at elevated locations, or other safeguards must be used to protect employees from falls.

(c) Ladders.

Conductive ladders can not be used near energized lines, except under special conditions.

Ladders used in structures must be secured in place to prevent accidental displacement.

(d) Live-line Tools.

Only live-line tools having a manufacturers certification shall be used on live-line work.

All live-line tools must be visually inspected before use. Tools showing defects of any kind must not be used.

(e) Measuring tapes or ropes.

Conductive tapes or ropes must not be used when working on or near energized parts.

(f) Handtools.

All portable electric handtools need to be either:

- (1) Properly grounded if they have metal frames
- (2) Of the double insulated type and identified as such
- (3) Connected to the power supply by means of an isolating power supply.

All Pneumatic tools used on or around energized lines or equipment shall:

- (1) Have nonconducting hoses
- (2) Have an accumulator on the compressor to collect moisture

1926.952 MECHANICAL EQUIPMENT

(a) General.

Visual inspections must be made on equipment each day.

Brakes on equipment shall be tested at the beginning of each shift.

All vehicles with the view to the rear obstructed must be equipped with reverse signal alarm, or be directed by an observer while backing up.

(b) Aerial lifts.

Aerial lifts near energized lines or equipment not insulated from the exposed lines or equipment, need to be grounded or barricaded, and are to be considered as energized.

Equipment or material must be passed to an employee in an aerial basket that is within reach of energized lines.

(c) Derrick trucks, cranes, and other lifting equipment.

All lifting equipment needs to be certified for the voltage it will be exposed to, or the equipment needs to be insulated or considered energized or grounded.

1926.953 MATERIAL HANDLING

(a) Unloading.

Prior to unloading material, the load needs to be examined thoroughly to assure that the unloading process will not be a danger to employees.

(b) Pole hauling.

During pole hauling, the poles will be secured to prevent movement, and a red flag attached to the trailing end of the longest pole. During darkness an illuminated warning device shall be attached to the longest pole.

(c) Storage.

Materials should not be stored under or near energized lines or equipment.

(d) Tag lines.

An established safety practice is to use a tag line to control loads handled by hoisting equipment.

(e) Oil filled equipment.

During construction or repair of oil filled equipment, the oil may be stored in temporary containers such as pillow tanks.

(f) Framing.

During framing operations, employees cannot work under loads suspended by hoisting equipment, unless additional adequate support is provided for the load.

(g) Attaching the load.

The hoist rope must not be wrapped around the load. Suitable underhook devices must be used to hold and control the load. This provision does not apply to electric construction crews when setting or removing poles.

1926.954 GROUNDING FOR PROTECTION OF EMPLOYEES

(a) General.

All conductors and equipment shall be treated as energized until tested or otherwise determined to be deenergized or until grounded.

(b) New construction.

New lines or equipment may be considered deenergized and worked as such where ground sets are installed or where the hazard of induced voltage is not present, and where new lines cannot contact energized lines or equipment.

(c) Communication.

Bare wire communication conductors on power poles or structures must be treated as energized unless protected by insulating materials.

(d) Voltage testing.

Deenergized conductors and equipment which are to be grounded, shall be tested for voltage and be locked and tagged out or be worked as if they are energized. For additional information see 1910.950(d).

(e) Attaching grounds.

When attaching grounds, the ground end shall be attached first, and the other end must be worked with insulated tools or suitable devices.

When removing grounds, the grounding device must first be removed from the line, or equipment with insulated tools or other suitable devices.

(f) Grounds.

Grounds shall be placed between the work location and all sources of energy. Grounds shall be placed as close to the work location as possible.

If grounds are not used, lines or equipment shall be worked as energized.

(g) Testing without grounds.

Grounds can be temporarily removed only for test purposes, and extreme caution must be exercised.

(h) Grounding electrodes.

Ground electrodes shall have a resistance to ground low enough to protect employees and operate protective devices.

(i) Grounding to tower.

Grounding to tower shall be made with a tower clamp capable of conducting the anticipated fault current.

(j) Ground lead.

All ground leads must be capable of conducting the anticipated fault current and have a minimum conductance of No. 2AWG copper.

1926.955 OVERHEAD LINES

(a) Overhead lines.

Prior to climbing poles, ladders, structures, or scaffolds, an evaluation shall be made to determine if it is safe to climb.

Employees standing on the ground must not contact equipment or machinery working adjacent to energized lines or equipment.

Lifting equipment must be bonded to an effective ground or it shall be considered energized and barricaded when working near energized lines or equipment.

Pole holes must be attended or guarded to protect employees.

Tag lines shall be of the nonconductive type when used near energized lines.

(b) Metal tower construction.

When working in unstable soil or other material, provisions shall be made for cleaning out auger-type footings without requiring an employee to enter the footings or excavation unless shoring or suitable protective systems are installed to protect employees.

A designated employee shall direct the movement of equipment adjacent to footing excavations.

Members and sections of towers being assembled must be adequately supported to protect employees.

Erection cranes shall be positioned on firm, level foundations with outriggers used.

A designated employee must assure that proper clearance is maintained while moving or placing equipment or materials under or near energized lines.

(c) Stringing or removing deenergized conductors.

Before stringing operations start:

- (1) A job briefing shall be conducted
- (2) The procedures to be followed must be established

Where a conductor can accidentally contact or receive an induced voltage, the conductor must be grounded and the employee must be insulated or isolated for protection.

When crossing over energized conductors of 600 volts or more, guards or nets must be used to protect employees from shock hazard or the employee must be insulated or isolated for protection. Also, the line being strung must be grounded or worked as energized.

While conductor or pulling line is being pulled (in motion) employees can not be under overhead operations or on crossarms.

Stringing and clipping shall not be performed during an electrical storm.

Reliable communications must be established between the reel tender and pulling rig operator.

(d) Stringing adjacent to energized lines.

An evaluation must be made so that a competent determination can be made to ascertain that induced voltage buildups will not occur, or the lines must be worked as energized.

All pulling and tensioning equipment must be isolated, insulated or grounded.

(e) Live-line bare-hand work.

Employees shall be instructed and trained in live-line bare-hand technique, and the safety requirements prior to starting work.

Only equipment designed, tested, and intended for live-line bare-hand work shall be used.

All live-line bare-hand work shall be personally supervised by a person trained and qualified to perform live-line bare-hand work.

1926.956 UNDERGROUND LINES

(a) Guarding and ventilating manholes and vaults.

Appropriate warning signs must be displayed when covers of manholes or vaults are removed.

(b) No entry can be made into manholes or vaults unless forced ventilation is provided, or the atmosphere is tested and found to be safe. Where unsafe conditions are detected, the space must be made safe before entry and a adequate continuous air supply provided.

(c) Trenching and excavating.

Trenching and excavating operations must comply with construction safety standard 1926.651 and 1926.652.

Underground utilities must be located prior to starting excavating, and must be protected as necessary to avoid damage.

Where multiple cables exist in an excavation, the cable not being worked must be protected.

Before cutting into a cable or opening a splice, the cable must be identified and verified to be the proper cable.

1926.957 CONSTRUCTION IN ENERGIZED SUBSTATIONS

(a) Work near energized equipment facilities.

Before work is started on energized substations, authorization must be obtained from the designated authorized person.

When work is to be done in an energized substation, the following shall be determined:

- (1) What facilities are energized

(2) What protective equipment and precautions are necessary for the safety of personnel

(b) Deenergized equipment and lines.

When it is necessary to deenergize equipment or lines for protection of employees, the requirements contained in construction safety standard 1926.950(d) must be followed.

(c) Barricades and barriers.

Barricades or barriers must be installed to prevent accidental contact with energized lines and equipment.

(d) Control panels.

Work on or adjacent to energized control panels must be performed by designated employees.

Precaution should be taken to prevent accidental operation of relays or other protective devices due to jarring, vibration, or improper wiring.

(e) Mechanized equipment.

All mobile cranes and devices must be effectively grounded when moved or operated close to energized lines or equipment.

(f) Substation fences.

Temporary fencing will be provided around substations where the permanent fence has been removed. The temporary fence must be grounded.

All gates to all unattended substations shall be kept locked.