Division 2/RR, Electric Power Generation, Transmission, and Distribution

437-002-2300 General.

(1) Application. Division 2/RR 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 that are accessible only to qualified employees;

Note to paragraph (1)(a): 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. This includes facilities producing electric energy from other forms of energy, including but not limited to thermal, hydroelectric, photovoltaic, wind-generated, wave energy, and chemical energy from fuel cells and batteries. Division 2/S covers supplementary electric generating equipment that is used to supply a workplace for emergency, standby, or similar purposes only.

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

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

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

(C) Chlorine and hydrogen systems;

(c) Test sites where employees perform electrical testing involving temporary measurements associated with electric power generation, transmission, and distribution 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 (1)(a) through (1)(C) of this rule; and

(e) Line-clearance tree-trimming performed for the purpose of clearing space around electric power generation, transmission, or distribution lines or equipment and on behalf of an organization that operates, or that controls the operating procedures for, those lines or equipment, as follows:

(A) Entire Division 2/RR , except paragraph (1) of 437-002-2317, applies to line-clearance tree trimming covered by the introductory text to paragraph (1)(e) of 437-002-2300 when performed by qualified employees (those who are knowledgeable in the construction and operation of the electric power generation, transmission, or distribution equipment involved, along with the associated hazards).

(B) Rules 437-002-2300(2), (3); 437-002-2301, 437-002-2302, 437-002-2306, 437-002-2310, 437-002-2315, and 437-002-2317 of Division 2/RR apply to line-clearance tree trimming covered by the introductory text to paragraph (1)(e) of 437-002-2300 when performed by line-clearance tree trimmers who are not qualified employees.

(f) Notwithstanding paragraph (1)(a) of this rule, Division 2/RR does not apply:

To electrical installations, electrical safety-related work practices, or electrical maintenance considerations covered by Division 2/S or Division 3/K.

Note 1 to paragraph (1)(f): Oregon OSHA considers work practices conforming to 1910.332 through 1910.335 of Division 2/S as complying with the electrical safety-related work-practice requirements of Division 2/RR identified in Table 1 of Appendix A-2 to Division 2/RR, provided that employers are performing the work on a generation or distribution installation meeting 1910.303 through 1910.308 of Division 2/S. This table also identifies provisions in Division 2/RR 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 Division 2/S.

Note 2 to paragraph (1)(f): Oregon OSHA considers work practices performed by qualified persons and conforming to Division 2/RR as complying with 1910.333(c) and 1910.335 of Division 2/S.

(g) Division 2/RR applies in addition to all other applicable standards contained in Division 2. Employers covered under Division 2/RR are not exempt from complying with other applicable provisions in Division 2 by the operation of 1910.5(c) of Division 2. Specific references in Division 2/RR to other subdivisions are for emphasis only.

(h) Division 2/RR also covers the construction of electric power transmission and distribution lines and equipment. As used in this Subdivision, 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. Division 2/RR applies to safety-related work practices for qualified employees.

(i) This rule applies in addition to all other applicable standards contained in Division 3, relating to construction activities. Employers engaged in construction activities covered under Division 2/RR are not exempt from complying with other applicable provisions in Division 3 by the operation of 437-003-0005 Additional Applicability, of Division 3/A. Specific references in Division 2/RR to other subdivisions of Division 3 are provided for emphasis only.

(2) Training.

(a) All employees performing work covered by this rule must be trained as follows:

(A) Each employee must be trained in, and familiar with, the safety-related work practices, safety procedures, and other safety requirements in this rule that pertain to their job assignments.

(B) Each employee must 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 rule but that are related to their work and are necessary for their safety.

(C) The degree of training must be determined by the risk to the employee for the hazard involved.

(b) Each qualified employee must 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 rule corresponding to the voltages to which the qualified employee will be exposed and the skills and techniques necessary to maintain those distances,

(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, and

(E) The recognition of electrical hazards to which the employee may be exposed and the skills and techniques necessary to control or avoid these hazards.
Note to paragraph (2)(b): For the purposes of this rule, a person must have the training required by paragraph (2)(b) of this rule to be considered a qualified employee.

(c) Each line-clearance tree trimmer who is not a qualified employee must 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, and

(C) The minimum approach distances specified in this rule corresponding to the voltages to which the employee will be exposed and the skills and techniques necessary to maintain those distances.

(d) The employer must 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 rule.

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

(A) If the supervision or annual inspections required by paragraph (2)(d) of this rule indicate that the employee is not complying with the safety-related work practices required by this rule, 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 they must employ safety-related work practices that are not normally used during their regular job duties.

Note to paragraph (2)(e)(C): Oregon OSHA considers tasks that are performed less often than once per year to necessitate retraining before the performance of the work practices involved.

(f) The training required by paragraph (a)(2) of this rule must be of the classroom or on-the-job type.

(g) The training must establish employee proficiency in the work practices required by this rule and must introduce the procedures necessary for compliance with this rule.

(h) The employer must ensure that each employee has demonstrated proficiency in the work practices involved before that employee is considered as having completed the training required by paragraph (a)(2) of this rule.

Note 1 to paragraph (2)(h): Though they are not required by this paragraph, employment records that indicate that an employee has successfully completed the required training are one way of keeping track of when an employee has demonstrated proficiency.

Note 2 to paragraph (2)(h): For an employee with previous training, an employer may determine that that employee has demonstrated the proficiency required by this paragraph using the following process:

(1) Confirm that the employee has the training required by paragraph (a)(2) of this rule,

(2) Use an examination or interview to make an initial determination that the employee understands the relevant safety-related work practices before they perform any work covered by this rule, and

(3) Supervise the employee closely until that employee has demonstrated proficiency as required by this paragraph.

(3) Information transfer.

(a) Before work begins, the host employer must inform contract employers of:

(A) The characteristics of the host employer's installation that are related to the safety of the work to be performed and are listed in paragraphs (4)(a) through (4)(e) of this rule;

Note to paragraph (3)(a)(A): This paragraph requires the host employer to obtain information listed in paragraphs (4)(a) through (4)(e) of this rule if it does not have this information in existing records.

(B) Conditions that are related to the safety of the work to be performed, that are listed in paragraphs (4)(f) through (4)(h) of this rule, and that are known to the host employer;

Note to paragraph (3)(a)(B): For the purposes of this paragraph, the host employer need only provide information to contract employers that the host employer can obtain from its existing records through the exercise of reasonable diligence. This paragraph does not require the host employer to make inspections of worksite conditions to obtain this information.

(C) Information about the design and operation of the host employer's installation that the contract employer needs to make the assessments required by this rule; and

Note to paragraph (3)(a)(C): This paragraph requires the host employer to obtain information about the design and operation of its installation that contract employers need to make required assessments if it does not have this information in existing records.

(D) Any other information about the design and operation of the host employer's installation that is known by the host employer, that the contract employer requests, and that is related to the protection of the contract employer's employees.

Note to paragraph (3)(a)(D): For the purposes of this paragraph, the host employer need only provide information to contract employers that the host employer can obtain from its existing records through the exercise of reasonable diligence. This paragraph does not require the host employer to make inspections of worksite conditions to obtain this information.

(b) Contract employers must comply with the following requirements:

(A) The contract employer must ensure that each of its employees is instructed in the hazardous conditions relevant to the employee's work that the contract employer is aware of as a result of information communicated to the contract employer by the host employer under paragraph (3)(a) of this rule.

(B) Before work begins, the contract employer must advise the host employer of any unique hazardous conditions presented by the contract employer's work.

(C) The contract employer must advise the host employer of any unanticipated hazardous conditions found during the contract employer's work that the host employer did not mention under paragraph (3)(a) of this rule. The contract employer must provide this information to the host employer within 2 working days after discovering the hazardous condition.

(c) The contract employer and the host employer must coordinate their work rules and procedures so that each employee of the contract employer and the host employer is protected as required by this rule.

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

(a) The nominal voltages of lines and equipment,

(b) The maximum switching-transient voltages,

(c) The presence of hazardous induced voltages,

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

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

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

(g) The condition of poles, and

(h) Environmental conditions relating to safety.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2301 Medical services and first aid.

When employees are performing General Industry activities, the employer must provide medical services and first aid as required by 437-002-0161. When employees are performing Construction activities, the employer must provide medical services and first aid as required by 1926.50. In addition to the requirements of 437-002-0161 and 1926.50, the following requirements also apply:

(1) First-aid/CPR training. When employees are performing work on, or associated with, exposed lines or equipment energized at 50 volts or more, persons with first-aid/CPR training must be available as follows:

(a) For field work involving two or more employees at a work location, at least two trained persons must be available. However, for line-clearance tree trimming operations performed by line-clearance tree trimmers who are not qualified employees, only one trained person need be available if all new employees are trained in first aid/CPR within 3 months of their hiring dates.

(b) For fixed work locations such as substations, the number of trained persons available must 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) each employee at the work location must be a trained employee.

(2) First-aid supplies. First-aid supplies required by 437-002-0161 and 1926.50 must be placed in weatherproof containers if the supplies could be exposed to the weather.

(3) First-aid kits. The employer must maintain each first-aid kit and ensure that it is readily available for use.

(a) For employers involved in general industry activities, the first aid kit must be inspected frequently enough to ensure that expended items are replaced, and at least once per year.

(b) For employers involved in construction activities, the first-aid supplies must be in individual sealed packages for each type of item, must be checked by the employer before being sent out to each job, and at least weekly to ensure expended items are replaced.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2302 Job briefing.

(1) Before each job.

(a) In assigning an employee or a group of employees to perform a job, the employer must provide the employee in charge of the job with all available information that relates to the determination of existing characteristics and conditions required by paragraph (4) of 437-002-2300.

(b) The employer must ensure that the employee in charge conducts a job briefing that meets paragraphs (2), (3), and (4) of this rule with the employees involved before they start each job.

(2) Subjects to be covered. The briefing must cover at least the following subjects:

(a) Hazards associated with the job

(b) Work procedures involved

(c) Special precautions

(d) Energy-source controls

(e) Personal protective equipment requirements

(3) Number of briefings.

(a) At least one job briefing must be conducted before the start of the first job of each day or shift even if the work or operations to be performed during the work day or shift are repetitive and similar.

(b) Additional job briefings must be held if significant changes, which might affect the safety of the employees, occur during the course of the work.

(4) Extent of briefing.

(a) A brief discussion is satisfactory if the work involved is routine and if the employees, by virtue of training and experience, can reasonably be expected to recognize and avoid the hazards involved in the job.

(b) A more extensive discussion must be conducted:

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

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

(5) Working alone. An employee working alone need not conduct a job briefing. However, the employer must ensure that the tasks to be performed are planned as if a briefing were required.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2303 Hazardous energy control procedures.

(1) Application. The provisions of this rule apply to the use of hazardous energy control procedures for the control of energy sources in installations for the purpose of electric power generation, including related equipment for communication or metering. Clearance procedures and hazardous energy control procedures for the deenergizing of electric energy sources that are used exclusively for purposes of transmission and distribution, and construction activities, are addressed in 437-002-2312 Deenergizing lines and equipment for employee protection.

Note: 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 Division 2/S, Electrical.

(2) General.

(a) The employer must 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.

(b) The employer's energy control program under paragraph (2) of this rule must meet the following requirements:

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

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

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

(ii) 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 must 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 must 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 must be designed to accept a lockout device.

(c) Procedures must be developed, documented, and used for the control of potentially hazardous energy covered in 437-002-2303.

(d) The procedure must 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.

(e) The employer must conduct a periodic inspection of the energy control procedure at least annually to ensure that the procedure and the provisions of 437-002-2303 are being followed.

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

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

(C) If lockout is used for energy control, the periodic inspection must 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 must 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 (2)(g) of this rule.

(E) The employer must certify that the inspections required by paragraph (2)(e) of this rule have been accomplished. The certification must 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 to paragraph (2)(e)(E): If normal work schedule and operation records demonstrate adequate inspection activity and contain the required information, no additional certification is required.

(f) The employer must 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 must include the following:

(A) Each authorized employee must 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 must 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 must 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.

(g) When tagout systems are used, employees must 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.

(h) Retraining must be provided by the employer as follows:

(A) Retraining must 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 must also be conducted whenever a periodic inspection under paragraph (2)(e) of this rule 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 must reestablish employee proficiency and must introduce new or revised control methods and procedures, as necessary.

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

(3) Protective materials and hardware.

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

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

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

(i) Tagout devices must 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.

(ii) Tagout devices must be so constructed as not to deteriorate when used in corrosive environments.

(B) Lockout devices and tagout devices must 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 must be standardized.

(C) Lockout devices must 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, must be substantial enough to prevent inadvertent or accidental removal. Tagout device attachment means must be of a non-reusable type, attachable by hand, self-locking, and nonreleasable with a minimum unlocking strength of no less than 50 pounds and must 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 must include provisions for the identification of the employee applying the device.

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

Note to paragraph (3)(b)(F): For specific provisions covering accident prevention tags, see 1910.145.

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

Note to paragraph (5): See also paragraph (7) of this rule, 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) must include the following elements and actions, and these procedures must be performed in the following sequence:

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

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

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

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

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

(B) Tagout devices must 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.

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

(ii) Where a tag cannot be affixed directly to the energy isolating device, the tag must 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.

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

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

(g) Before starting work on machines or equipment that have been locked out or tagged out, the authorized employee must 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 must 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 must be followed and actions taken by the authorized employees to ensure the following:

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

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

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

(d) Each lockout or tagout device must 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 must 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 must 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.

(a) 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 must be followed:

(A) Clear the machine or equipment of tools and materials in accordance with paragraph (7)(a) of this rule;

(B) Remove employees from the machine or equipment area in accordance with paragraphs (7)(b) and (7)(c) of this rule;

(C) Remove the lockout or tagout devices as specified in paragraph (7)(d) of this rule;

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

(E) Deenergize all systems and reapply energy control measures in accordance with paragraph (6) of this rule to continue the servicing or maintenance.

(b) When servicing or maintenance is performed by a crew, craft, department, or other group, they must 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 must be used in accordance with the procedures required by paragraphs (2)(c) and (2)(d) of this rule including, but not limited to, the following specific requirements:

(A) Primary responsibility must 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 must 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 must be given to an authorized employee designated to coordinate affected work forces and ensure continuity of protection; and

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

(c) Procedures must 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.

(d) Whenever outside servicing personnel are to be engaged in activities covered in 437-002-2303, the on-site employer and the outside employer must inform each other of their respective lockout or tagout procedures, and each employer must ensure that his or her personnel understand and comply with restrictions and prohibitions of the energy control procedures being used.

(e) 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 must 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 must place and remove lockout and tagout devices in place of the authorized employee under paragraphs (4), (6)(d), and (7)(d) of this rule.

(C) Provisions must 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.

Note to 437-002-2303: Lockout and tagging procedures that comply with paragraphs (c) through (f) of 1910.147 will also be deemed to comply with 437-002-2303 if the procedures address the hazards covered by 437-002-2303.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2304 Enclosed spaces.

This rule covers enclosed spaces that may be entered by employees. It does not apply to vented vaults if the employer makes a determination that the ventilation system is operating to protect employees before they enter the space. This rule applies to routine entry into enclosed spaces in lieu of the confined space entry requirements contained in 437-002-0146 (4) through (11). If, after the employer takes the precautions given in 437-002-2304 and 437-002-2319 of Division 2/RR, the hazards remaining in the enclosed space endanger the life of an entrant or could interfere with an entrant's escape from the space, then entry into the enclosed space must meet the permit-space entry requirements of 437-002-0146 (4) through (11), Confined spaces, in Division 2/J.

(1) Safe work practices. The employer must 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. Each employee who enters an enclosed space or who serves as an attendant must be trained in the hazards of enclosed-space entry, in enclosed-space entry procedures, and in enclosed-space rescue procedures.

(3) Rescue equipment. Employers must provide equipment to ensure the prompt and safe rescue of employees from the enclosed space.

(4) Evaluating potential hazards. Before any entrance cover to an enclosed space is removed, the employer must 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 must be eliminated before the cover is removed.

Note to paragraph (4): The determination called for in this paragraph may consist of a check of the conditions that might foreseeably be in the enclosed space. For example, the cover could be checked to see if it is hot and, if it is fastened in place, could be loosened gradually to release any residual pressure. An evaluation also needs to be made of whether conditions at the site could cause a hazardous atmosphere, such as an oxygen-deficient or flammable atmosphere, to develop within the space.

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

(6) Hazardous atmosphere. Employees may not enter any enclosed space while it contains a hazardous atmosphere, unless the entry conforms to the confined space standard, 437-002-0146 Confined spaces, in Division 2/J.

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

Note to paragraph (7): See 437-002-2319 Underground electrical installations, for additional requirements on attendants for work in manholes and vaults.

(8) Calibration of test instruments. Test instruments used to monitor atmospheres in enclosed spaces must be kept in calibration and must have a minimum accuracy of ±10 percent.

(9) Testing for oxygen deficiency. Before an employee enters an enclosed space, the atmosphere in the enclosed space must 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 offsite 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 must 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 must be performed after the oxygen testing and ventilation required by paragraph (9) of this rule demonstrate that there is sufficient oxygen to ensure the accuracy of the test for flammability.

(11) Ventilation and monitoring for flammable gases or vapors. If flammable gases or vapors are detected or if an oxygen deficiency is found, forced-air ventilation must 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 above safe levels occurs may be followed in lieu of ventilation if flammable gases or vapors are initially detected at safe levels.

Note to paragraph (11): See the definition of "hazardous atmosphere" for guidance in determining whether a specific concentration of a substance is hazardous.

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

(13) Air supply. The air supply for the continuous forced-air ventilation must 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 must 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 must 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 to paragraph (14): See the definition of "hazardous atmosphere" for guidance in determining whether a specific concentration of a substance is hazardous.
Note to 437-002-2304 : Entries into enclosed spaces conducted in accordance with the requirements of 437-002-0146 (4) through (11), Confined spaces, are considered as complying with 437-002-2304 of Division 2/RR.

Stat. Auth.: ORS 654.025(2) and 656.726(4)

Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2305 Excavations.

Excavation operations must comply with Division 3/P.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2306 Personal protective equipment.

(1) General. For employers engaged in general industry activities, personal protective equipment must meet the requirements of 437-002-0134. For employers engaged in construction activities, personal protective equipment must meet the requirements of 437-003-0134.

Note 1: 437-002-0134 (4) and 437-003-0134 (4) set employer payment obligations for the personal protective equipment required by this rule, including, but not limited to, the fall protection equipment required by paragraph (2) of this rule, the electrical protective equipment required by 437-002-2311(3) of Division 2/RR, and the flame-resistant and arc-rated clothing and other protective equipment required by 437-002-2311(8) of Division 2/RR.

Note 2: For general industry activities, refer to Division 2/I, 1910.137, for Electrical Protective Equipment requirements. For construction activities, refer to Division 3/E, 1926.97, for Electrical Protective Equipment requirements.

(2) Fall protection.

(a) Personal fall arrest systems must meet the requirements of Division 3/M, as required by 437-002-0134(5) of Division 2 and 437-003-0134(5) of Division 3.

(b) Personal fall arrest equipment used by employees who are exposed to hazards from flames or electric arcs, as determined by the employer under 437-002-2311(8)(a) of Division 2/RR, must be capable of passing a drop test equivalent to that required by paragraph (2)(c)(L) of this rule after exposure to an electric arc with a heat energy of 40±5 cal/cm2.

(c) Body belts and positioning straps for work-positioning equipment must meet the following requirements:

(A) Hardware for body belts and positioning straps must meet the following requirements:

(i) Hardware must be made of drop-forged steel, pressed steel, formed steel, or equivalent material.

(ii) Hardware must have a corrosion-resistant finish.

(iii) Hardware surfaces must be smooth and free of sharp edges.

(B) Buckles must be capable of withstanding an 8.9-kilonewton (2,000-pound-force) tension test with a maximum permanent deformation no greater than 0.4 millimeters (0.0156 inches).

(C) D rings must be capable of withstanding a 22-kilonewton (5,000-pound-force) tensile test without cracking or breaking.

(D) Snaphooks must be capable of withstanding a 22-kilonewton (5,000-pound-force) tension test without failure.

Note to paragraph (2)(c)(D) of this rule: Distortion of the snaphook sufficient to release the keeper is considered to be tensile failure of a snaphook.

(E) Top grain leather or leather substitute may be used in the manufacture of body belts and positioning straps; however, leather and leather substitutes may not be used alone as a load-bearing component of the assembly.

(F) Plied fabric used in positioning straps and in load-bearing parts of body belts must be constructed in such a way that no raw edges are exposed and the plies do not separate.

(G) Positioning straps must be capable of withstanding the following tests:

(i) A dielectric test of 819.7 volts, AC, per centimeter (25,000 volts per foot) for 3 minutes without visible deterioration;

(ii) A leakage test of 98.4 volts, AC, per centimeter (3,000 volts per foot) with a leakage current of no more than 1 mA;

Note to paragraphs (2)(c)(G)(i) and (2)(c)(G)(ii): Positioning straps that pass direct-current tests at equivalent voltages are considered as meeting this requirement.

(iii) Tension tests of 20 kilonewtons (4,500 pounds-force) for sections free of buckle holes and of 15 kilonewtons (3,500 pounds-force) for sections with buckle holes;

(iv) A buckle-tear test with a load of 4.4 kilonewtons (1,000 pounds-force); and

(v) A flammability test in accordance with Table RR-1.

TABLE RR-1-FLAMMABILITY TEST

Test method	Criteria for passing the test
Vertically suspend a 500-mm (19.7-inch) length of strapping supporting a 100-kg (220.5-lb) weight.	
Use a butane or propane burner with a 76-mm (3-inch) flame. Direct the flame to an edge of the strapping at a distance of 25 mm (1 inch). Remove the flame after 5 seconds. Wait for any flames on the positioning strap to stop burning.	Any flames on the positioning strap must self extinguish. The positioning strap must continue to support the 100-kg (220.5-lb) mass.

(H) The cushion part of the body belt must contain no exposed rivets on the inside and must be at least 76 millimeters (3 inches) in width.

(I) Tool loops must be situated on the body of a body belt so that the 100 millimeters (4 inches) of the body belt that is in the center of the back, measuring from D ring to D ring, is free of tool loops and any other attachments.

(J) Copper, steel, or equivalent liners must be used around the bars of D rings to prevent wear between these members and the leather or fabric enclosing them.

(K) Snaphooks must be of the locking type meeting the following requirements:

(i) The locking mechanism must first be released, or a destructive force must be placed on the keeper, before the keeper will open.

(ii) A force in the range of 6.7 N (1.5 lbf) to 17.8 N (4 lbf) must be required to release the locking mechanism.

(iii) With the locking mechanism released and with a force applied on the keeper against the face of the nose, the keeper may not begin to open with a force of 11.2 N (2.5 lbf) or less and must begin to open with a maximum force of 17.8 N (4 lbf).

(L) Body belts and positioning straps must be capable of withstanding a drop test as follows:

(i) The test mass must be rigidly constructed of steel or equivalent material with a mass of 100 kg (220.5 lbm). For work-positioning equipment used by employees weighing more than 140 kg (310 lbm) fully equipped, the test mass must be increased proportionately (that is, the test mass must equal the mass of the equipped worker divided by 1.4).

(ii) For body belts, the body belt must be fitted snugly around the test mass and must be attached to the test structure anchorage point by means of a wire rope.

(iii) For positioning straps, the strap must be adjusted to its shortest length possible to accommodate the test and connected to the test-structure anchorage point at one end and to the test mass on the other end.

(iv) The test mass must be dropped an unobstructed distance of 1 meter (39.4 inches) from a supporting structure that will sustain minimal deflection during the test.

(v) Body belts must successfully arrest the fall of the test mass and must be capable of supporting the mass after the test.

(vi) Positioning straps must successfully arrest the fall of the test mass without breaking, and the arrest force may not exceed 17.8 kilonewtons (4,000 pounds-force). Additionally, snaphooks on positioning straps may not distort to such an extent that the keeper would release.

Note to paragraph (2)(c) of this rule: When used by employees weighing no more than 140 kg (310 lbm) fully equipped, body belts and positioning straps that conform to American Society of Testing and Materials Standard Specifications for Personal Climbing Equipment, ASTM F887-12e1, are deemed to be in compliance with paragraph (2)(c) of this rule.

(d) The following requirements apply to the care and use of personal fall protection equipment.

(A) Body belts and positioning straps must never be stored with sharp or edged tools.

(B) Small tools carried in the belt must be placed so they present the least danger of coming in accidental contact with energized parts. Sharp or pointed tools must not be carried unless in scabbards, or are otherwise effectively safeguarded.

(C) Work-positioning equipment must be inspected before use each day to determine that the equipment is in safe working condition. Work-positioning equipment that is not in safe working condition may not be used.

Note to paragraph (2)(d)(C): Appendix F to Division 2/RR contains guidelines for inspecting work-positioning equipment.

(D) The use of chainsaws is prohibited on all overhead work where workers are supported by a single climbing belt or rope.

(E) Workers must not place positioning straps around the pole above the top crossarm except where adequate protection is taken to prevent it from slipping over the top of the pole. Workers must not allow either end of a strap to hang loose, either in climbing or descending poles or other structures.

(F) Gaffs and Climbers.

(i) Gaffs and Climbers must be maintained according to the manufacturer's recommendations.

(ii) Workers must remove climbers before driving any vehicle.

(iii) Climbers must not be worn except when required. Workers must not continue to wear their climbers while working on the ground except for brief periods when a worker is necessarily off the pole.

(iv) While climbers are not being worn, the gaffs must be properly guarded.

(G) Safety lines must be readily available while working aloft to be used for emergency rescue such as lowering a worker to the ground. Such safety lines must be a minimum of one-half-inch diameter and three or four strand first-grade manila or its equivalent in strength (2,650 lb.) and durability.

(H) Personal fall arrest systems must be used in accordance with 1926.502(d).

Note to paragraph (2)(d)(H): Fall protection equipment rigged to arrest falls is considered a fall arrest system and must meet the applicable requirements for the design and use of those systems. Fall protection equipment rigged for work positioning is considered work-positioning equipment and must meet the applicable requirements for the design and use of that equipment.

(I) The employer must ensure that employees use fall protection systems as follows:

(i) Each employee working from an aerial lift must use a fall restraint system or a personal fall arrest system. Paragraph (c)(2)(v) of 1910.67 and paragraph (b)(2)(v) of 1926.453 do not apply.

(ii) Except as provided in paragraph (2)(d)(I)(iii) of this rule, each employee in elevated locations more than 1.2 meters (4 feet) above the ground on poles, towers, or similar structures must use a personal fall arrest system, work-positioning equipment, or fall restraint system, as appropriate, if the employer has not provided other fall protection meeting Division 2/D, Walking-Working Surfaces; or Division 3/M, Fall Protection.

(iii) Each qualified employee climbing or changing location on poles, towers, or similar structures must use fall protection equipment unless the employer can demonstrate that climbing or changing location with fall protection is infeasible or creates a greater hazard than climbing or changing location without it.

Note 1 to paragraphs (2)(d)(I)(ii) and (2)(d)(I)(iii) of this rule: These paragraphs apply to structures that support overhead electric power transmission and distribution lines and equipment. They do not apply to portions of buildings, such as loading docks, or to electric equipment, such as transformers and capacitors. Division 2/D, and Division 3/M contain the duty to provide fall protection associated with walking and working surfaces.

(J) Work-positioning equipment must be rigged so that an employee can free fall no more than 0.6 meters (2 feet).

(K) Anchorages for work-positioning equipment must be capable of supporting at least twice the potential impact load of an employee's fall, or 13.3 kilonewtons (3,000 pounds-force), whichever is greater.

Note to paragraph (2)(d)(K): Wood-pole fall-restriction devices meeting American Society of Testing and Materials Standard Specifications for Personal Climbing Equipment, ASTM F887-12e1, are deemed to meet the anchorage-strength requirement when they are used in accordance with manufacturers' instructions.

(L) Unless the snaphook is a locking type and designed specifically for the following connections, snaphooks on work-positioning equipment may not be engaged:

(i) Directly to webbing, rope, or wire rope;

(ii) To each other;

(iii) To a D ring to which another snaphook or other connector is attached;

(iv) To a horizontal lifeline; or

(v) To any object that is incompatibly shaped or dimensioned in relation to the snaphook such that accidental disengagement could occur should the connected object sufficiently depress the snaphook keeper to allow release of the object.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2307 Portable ladders and platforms.

(1) General. For employers involved in general industry activities, requirements for portable ladders contained in Division 2/D apply in addition to the requirements of this rule, except as specifically noted in paragraph (2) of this rule. For employers involved in construction activities, requirements for portable ladders contained in Division 3/X apply in addition to the requirements of this rule, except as specifically noted in paragraph (2) of this rule.

(2) Special ladders and platforms. For general industry activities, portable ladders used on structures or conductors in conjunction with overhead line work need not meet 1910.25(d)(2)(i) and (d)(2)(iii) or 1910.26(c)(3)(iii). For construction activities, portable ladders and platforms used on structures or conductors in conjunction with overhead line work need not meet 1926.1053(b)(5)(i) and (b)(12). Portable ladders and platforms used on structures or conductors in conjunction with overhead line work must meet the following requirements:

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

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

(c) Portable ladders and platforms must be secured to prevent them from becoming dislodged.

(d) Portable ladders and platforms may be used only in applications for which they are designed.

(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 must be used when the employer demonstrates that nonconductive ladders would present a greater hazard to employees than conductive ladders.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2308 Hand and portable power equipment.

(1) General. Paragraph (2) of this rule applies to electric equipment connected by cord and plug. Paragraph (3) of this rule applies to portable and vehicle-mounted generators used to supply cord- and plug-connected equipment. Paragraph (4) of this rule applies to hydraulic and pneumatic tools.

(2) Cord- and plug-connected equipment. For general industry activities, cord- and plug-connected equipment not covered by Division 2/S must comply with one of the following instead of 1910.243(a)(5); and for construction activities, cord- and plug-connected equipment not covered by Division 3/K must comply with one of the following instead of 1926.302(a)(1):

(a) The equipment must be equipped with a cord containing an equipment grounding conductor connected to the equipment frame and to a means for grounding the other end of the conductor (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) The equipment must be of the double-insulated type conforming to Division 2/S or Division 3/K; or

(c) The equipment must be connected to the power supply through an isolating transformer with an ungrounded secondary of not more than 50 volts.

(3) Portable and vehicle-mounted generators. Portable and vehicle-mounted generators used to supply cord- and plug-connected equipment covered by paragraph (2) of this section must meet the following requirements:

(a) 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.

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

(c) For vehicle-mounted generators, the frame of the generator must be bonded to the vehicle frame.

(d) Any neutral conductor must be bonded to the generator frame.

(4) Hydraulic and pneumatic tools.

Note: Hydraulic fluid in insulating tools. Paragraph (d)(1) of 1926.302 does not apply to hydraulic fluid used in insulating sections of hydraulic tools.

(a) Safe operating pressures for hydraulic and pneumatic tools, hoses, valves, pipes, filters, and fittings may not be exceeded.

Note to paragraph (4)(a) of this rule: If any hazardous defects are present, no operating pressure is 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.

(b) A hydraulic or pneumatic tool used where it may contact exposed energized parts must be designed and maintained for such use.

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

Note to paragraph (4)(c) of this rule: Use of hydraulic lines that do not have check valves and that have a separation of more than 10.7 meters (35 feet) between the oil reservoir and the upper end of the hydraulic system promotes the formation of a partial vacuum.

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

(e) Pressure must be released before connections are broken, unless quick acting, self-closing connectors are used.

(f) Employers must ensure that employees do not use any part of their bodies to locate, or attempt to stop, a hydraulic leak.

(g) Hoses may not be kinked.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2309 Live-line tools.

(1) Live-line tools must be used by employees when doing work on energized lines and equipment in excess of 5,000 volts.

(2) Live-line tools must be used while handling foreign objects that are in contact with high voltage equipment or conductors energized in excess of 5,000 volts.

(3) Only live-line tools that are tested and warranted by the manufacturer at the time of purchase to be adequate for the voltage involved must be used.

(4) Design of tools. Live-line tool rods, tubes, and poles must be designed and constructed to withstand the following minimum tests:

(a) If the tool is made of fiberglass-reinforced plastic (FRP), it must withstand 328,100 volts per meter (100,000 volts per foot) of length for 5 minutes, or

Note to paragraph (4)(a): Live-line tools using rod and tube that meet ASTM F711-02 (2007), Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools, are deemed to comply with paragraph (4) of this rule.

(b) If the tool is made of wood, it must withstand 246,100 volts per meter (75,000 volts per foot) of length for 3 minutes, or

(c) The tool must withstand other tests that the employer can demonstrate are equivalent.

(5) Condition of tools.

(a) Each live-line tool must be wiped clean and visually inspected for defects before use each day.

(b) 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 must be removed from service and examined and tested according to paragraph (5)(c) of this rule before being returned to service.

(c) Live-line tools used for primary employee protection must be removed from service every 2 years, and whenever required under paragraph (5)(b) of this rule, for examination, cleaning, repair, and testing as follows:

(A) Each tool must 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 must be repaired and refinished or must be permanently removed from service. If no such defect or contamination is found, the tool must be cleaned and waxed.

(C) The tool must be tested in accordance with paragraphs (5)(c)(D) and (5)(c)(E) of this rule under the following conditions:

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

(ii) 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 during use.

(D) The test method used must 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 must be as follows:

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

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

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

(d) Live-line tools may not be used when rain, fog, or any other factor is sufficient to reduce their insulating qualities so that leakage can be felt.

(e) Live-line tools must be kept in a dry place. When transporting, they must be kept in separate special storage compartments, or be contained in protective bags. They may not be laid directly on the ground.

Note to paragraph (5) of this rule: Guidelines for the examination, cleaning, repairing, and in-service testing of live-line tools are specified in the Institute of Electrical and Electronics Engineers' IEEE Guide for Maintenance Methods on Energized Power Lines, IEEE Std 516-2009.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2310 Materials handling and storage.

(1) General. For general industry activities, materials handling and storage must comply with applicable material handling and material storage requirements in Division 2, including those in Division 2/N, except for Helicopters, which must comply with 437-002-2323. For construction activities, materials handling and storage must comply with applicable material handling and material storage requirements in Division 3, including those in Division 3/N and Division 3/CC, except for Helicopters, which must comply with 437-002-2323.

(2) Materials storage near energized lines or equipment.

(a) In areas to which access is 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 a distance that provides for the maximum sag and side swing of all conductors and for the height and movement of material-handling equipment:

(A) For lines and equipment energized at 50 kilovolts or less, the distance is 3.05 meters (10 feet).

(B) For lines and equipment energized at more than 50 kilovolts, the distance is 3.05 meters (10 feet) plus 0.10 meter (4 inches) for every 10 kilovolts over 50 kilovolts.

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

Note to paragraph (2)(b): 437-002-2320(1) Substations; and 437-002-2321(3) Power Generation Installations; of Division 2/RR, specify the size of the working space.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2311 Working on or near exposed energized parts.
This rule applies to work on or near exposed live parts.

(1) General.

(a) Only qualified employees may work on or with exposed energized lines or parts of equipment.

(b) Only qualified employees may work in areas containing unguarded, uninsulated energized lines or parts of equipment operating at 50 volts or more.

(c) Electric lines and equipment must be considered and treated as energized unless they have been deenergized in accordance with 437-002-2303 Hazardous Energy Control, or 437-002-2312, of Division 2/RR.

(2) Two worker rules.

(a) Not fewer than two qualified employees may work on lines or equipment energized at more than 600 volts while performing the following types of work:

(A) Installation, removal, or repair of lines 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, the electrical hazards posed by operations listed specifically in paragraphs (2)(a)(A) through (2)(a)(E) of this section.

(b) The following exceptions to the two-worker rule in 437-002-2311(2)(a)(A) through (2)(a)(E) apply:

(A) When re-fusing circuits with a live-line tool.

(B) When operating switches by means of operating handles or live-line tools, excluding installation or removal of load break elbows with live line tools, addressed in paragraph (2)(b)(E) of this rule.

(C) When a qualified apprentice is assigned to work with a journeyman for the purpose of training.

(D) When installing or removing a live-line clamp connection with an approved live-line tool on single phase line or apparatus, providing that the connection or disconnection does not interrupt or pick up a load.

(E) Routine circuit switching, including installation or removal of a load break elbow with a live line tool on a single phase line or apparatus, with only one potential primary source.

(i) Authorized employees must conduct an inspection to determine that conditions on the site allow for safe work. Conditions include the following examples:

(I) Physical condition of the cable, elbows, apparatus, and switching equipment.

(II) Environmental and work conditions, such as limited visibility, bad weather, restricted working space, and poor lighting.

(III) Service life of the elbow, power cable, and apparatus.

(ii) When an employee requests a second worker on site, a second worker must be provided.

(F) Emergency repairs to the extent necessary to safeguard the general public.

(G) Work performed with live-line tools when the position of the employee is such that he or she is neither within reach of, nor otherwise exposed to contact with, energized parts.

(c) Proximity. Workers within reach of each other must not work on different phases of the same circuit, on different circuits, or on one energized phase and a ground conductor at the same time.

(3) Minimum approach distances.

(a) The employer must establish minimum approach distances no less than the distances computed by Table RR-2 for ac systems or Table RR-7 for dc systems.

(b) For voltages over 72.5 kilovolts, the employer must determine the maximum anticipated per-unit transient overvoltage, phase-to-ground, through an engineering analysis or assume a maximum anticipated per-unit transient overvoltage, phase-to-ground, in accordance with Table RR-8. When the employer uses portable protective gaps to control the maximum transient overvoltage, the value of the maximum anticipated per-unit transient overvoltage, phase-to-ground, must provide for five standard deviations between the statistical sparkover voltage of the gap and the statistical withstand voltage corresponding to the electrical component of the minimum approach distance. The employer must make any engineering analysis conducted to determine maximum anticipated per-unit transient overvoltage available upon request to employees and to Oregon OSHA for examination and copying.

Note to paragraph (3)(b): See Appendix B to Division 2/RR for information on how to calculate the maximum anticipated per-unit transient overvoltage, phase-to-ground, when the employer uses portable protective gaps to reduce maximum transient overvoltages.

(c) The employer must ensure that no employee approaches or takes any conductive object closer to exposed energized parts than the employer's established minimum approach distance, unless:

(A) The employee is insulated from the energized part. Rubber insulating gloves or rubber insulating gloves and sleeves worn in accordance with paragraph (4) of this rule constitutes insulation of the employee from the energized part upon which the employee is working provided that the employee has control of the part in a manner sufficient to prevent exposure to uninsulated portions of the employee's body; or

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

(C) Live-line barehand work is prohibited in Oregon.

(4) Type of insulation: Adequate barriers and clearances.

(a) Protective equipment and devices must be installed or removed with:

(A) Rubber gloves or hot sticks on conductors or equipment energized at 5,000 volts or less.

(B) Live line tools for conductors or equipment energized in excess of 5,000 volts.

(C) Rubber protective equipment may be considered as adequate barriers when used on voltages for which it is rated. Rubber gloves may be used as additional protection from accidental contact only on voltages above 5,000 and not over 15,000 volts phase to ground.

(D) Rubber gloves cannot be used as primary protection on voltages over 5,000 volts.

(E) Fixed protective guards and barriers, when installed and maintained according to the manufacturer’s guidelines, may be considered as providing adequate clearance.

(b) When an employee uses rubber insulating gloves as insulation from energized parts (under paragraph (3)(c)(A) of this rule), the employer must ensure that the employee also uses rubber insulating sleeves. However, an employee need not use rubber insulating sleeves if:

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

(B) When installing insulation for purposes of paragraph (4)(b)(A) of this rule, the employee installs the insulation from a position that does not expose their upper arms to contact with other energized parts.

(c) When an employee uses rubber insulating gloves or rubber insulating gloves and sleeves as insulation from energized parts (under paragraph (3)(c)(A) of this rule), the employer must ensure that the employee:

(A) Puts on the rubber insulating gloves and sleeves in a position where they cannot reach into the minimum approach distance, established by the employer under paragraph (3)(a) of this rule; and

(B) Does not remove the rubber insulating gloves and sleeves until they are in a position where they cannot reach into the minimum approach distance, established by the employer under paragraph (3)(a) of this rule.

(5) Working position.

(a) The employer must 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's.

(b) When an employee performs work near exposed parts energized at more than 600 volts, but not more than 72.5 kilovolts, and is not wearing rubber insulating gloves, being protected by insulating equipment covering the energized parts, performing work using live-line tools, the employee must work from a position where he or she cannot reach into the minimum approach distance, established by the employer under paragraph (3)(a) of this rule.

(6) Making connections. The employer must ensure that employees make connections as follows:

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

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

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

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

(8) Protection from flames and electric arcs.

(a) The employer must assess the workplace to identify employees exposed to hazards from flames or from electric arcs.

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

Note 1 to paragraph (8)(b): Appendix E to Division 2/RR provides guidance on estimating available heat energy. Oregon OSHA will deem employers following the guidance in Appendix E to Division 2/RR to be in compliance with paragraph (8)(b) of this rule. An employer may choose a method of calculating incident heat energy not included in Appendix E to Division 2/RR if the chosen method reasonably predicts the incident energy to which the employee would be exposed.

Note 2 to paragraph (8)(b): This paragraph does not require the employer to estimate the incident heat energy exposure for every job task performed by each employee. The employer may make broad estimates that cover multiple system areas provided the employer uses reasonable assumptions about the energy-exposure distribution throughout the system and provided the estimates represent the maximum employee exposure for those areas. For example, the employer could estimate the heat energy just outside a substation feeding a radial distribution system and use that estimate for all jobs performed on that radial system.

(c) The employer must ensure that each employee who is exposed to hazards from flames or electric arcs does not wear clothing that could melt onto their skin or that could ignite and continue to burn when exposed to flames or the heat energy estimated under paragraph (8)(b) of this rule.

Note to paragraph (8)(c) of this rule: This paragraph prohibits clothing made from acetate, nylon, polyester, rayon and polypropylene, either alone or in blends, unless the employer demonstrates that the fabric has been treated to withstand the conditions that may be encountered by the employee or that the employee wears the clothing in such a manner as to eliminate the hazard involved.

(d) The employer must ensure that the outer layer of clothing worn by an employee, except for clothing not required to be arc rated under paragraphs (8)(e)(A) through (8)(e)(E) of this rule, is flame resistant under any of the following conditions:

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

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

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

Note to paragraph (8)(d)(C): This paragraph does not apply to conductors that are capable of carrying, without failure, the maximum available fault current for the time the circuit protective devices take to interrupt the fault.

(D) The incident heat energy estimated under paragraph (8)(b) of this rule exceeds 2.0 cal/cm2.

(e) The employer must ensure that each employee exposed to hazards from electric arcs wears protective clothing and other protective equipment with an arc rating greater than or equal to the heat energy estimated under paragraph (8)(b) of this rule whenever that estimate exceeds 2.0 cal/cm2. This protective equipment must cover the employee's entire body, except as follows:

(A) Arc-rated protection is not necessary for the employee's hands when the employee is wearing rubber insulating gloves with protectors or, if the estimated incident energy is no more than 14 cal/cm2, heavy-duty leather work gloves with a weight of at least 407 gm/m2 (12 oz/yd2),

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

(C) Arc-rated protection is not necessary for the employee's head when the employee is wearing head protection meeting 437-002-0134(9) and 437-003-0134(9) if the estimated incident energy is less than 9 cal/cm2 for exposures involving single-phase arcs in open air or 5 cal/cm2 for other exposures,

(D) The protection for the employee's head may consist of head protection meeting 437-002-0134(9) and 437-003-0134(9), and a faceshield with a minimum arc rating of 8 cal/cm2 if the estimated incident-energy exposure is less than 13 cal/cm2 for exposures involving single-phase arcs in open air or 9 cal/cm2 for other exposures, and

(E) For exposures involving single phase arcs in open air, the arc rating for the employee's head and face protection may be 4 cal/cm2 less than the estimated incident energy.

Note to paragraph (8): See Appendix E to Division 2/RR for further information on the selection of appropriate protection.

(9) Fuse handling. When an employee must install or remove fuses with one or both terminals energized at more than 300 volts, or with exposed parts energized at more than 50 volts, the employer must ensure that the employee uses tools or gloves rated for the voltage. When an employee installs or removes expulsion-type fuses with one or both terminals energized at more than 300 volts, the employer must ensure that the employee wears eye protection meeting the requirements of Division 2/I and Division 3/E, uses a tool rated for the voltage, and is clear of the exhaust path of the fuse barrel.

(10) Covered (non-insulated) conductors. The requirements of this section that pertain to the hazards of exposed live parts also apply when an employee performs work in proximity to covered (non-insulated) wires.

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

(12) Opening and closing circuits under load.

(a) The employer must ensure that devices used by employees to open circuits under load conditions are designed to interrupt the current involved.

(b) The employer must ensure that devices used by employees to close circuits under load conditions are designed to safely carry the current involved.

(13) Safety Watch

(a) A qualified safety watch must be provided in areas where inadvertent motions, movements, or tool use would violate Minimum Approach Distances (MAD). The safety watch's sole duty is to keep constant watch over persons working within the MAD, to warn them of danger, and to stop the work when necessary.

(b) The foreman or other worker in charge of the work being performed is responsible for the designation of the safety watch. It is the responsibility of the worker in charge to select a qualified worker who is capable and familiar with the work.

(c) The worker in charge may act as a safety watch providing no other duties interfere. If the worker in charge is distracted or must leave the immediate vicinity, that worker must either designate another qualified person as the safety watch or order the work stopped.

(d) Use of vehicles, gin poles, cranes, and other equipment in restricted or hazardous areas must at all times be monitored by a qualified safety watch other than the equipment operator.

TABLE RR-2-AC LIVE-LINE WORK MINIMUM APPROACH DISTANCE

[The minimum approach distance (MAD; in meters) must conform to the following equations.]

For phase-to-phase system voltages of 50 V to 300 V: [1]

MAD = avoid contact

For phase-to-phase system voltages of 301 V to 5 kV: [1]

MAD = M + D, where

D = 0.02 m .... the electrical component of the minimum approach distance.

M = 0.31 m for voltages up to 750 V and 0.61 m otherwise .... the inadvertent movement factor.

For phase-to-phase system voltages of 5.1 kV to 72.5 kV: [1]

MAD = M + AD, where

M = 0.61 m .... the inadvertent movement factor.

A = the applicable value from Table RR-4 .... the altitude correction factor.

D = the value from Table R-4 corresponding to the voltage and exposure or the value of the electrical component of the minimum approach distance calculated using the method provided in Appendix B to this rule. the electrical component of the minimum approach distance.

For phase-to-phase system voltages of more than 72.5 kV, nominal: [2 4]

MAD = $0.3048(C +)V_{L\text{-}G}TA + M$, where

C = 0.01 for phase-to-ground exposures that the employer can demonstrate consist only of air across the approach distance (gap),

0.01 for phase-to-phase exposures if the employer can demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap, or

0.011 otherwise

V_{L-G} = phase-to-ground rms voltage, in kV

T = maximum anticipated per-unit transient overvoltage; for phase-to-ground exposures, *T* equals T_{L-G}, the maximum per-unit transient overvoltage, phase-to-ground, determined by the employer under paragraph (l)(3)(ii) of this rule; for phase-to-phase exposures, T equals $1.35T_{L-G} + 0.45$

A = altitude correction factor from Table RR-4

M = 0.31 m, the inadvertent movement factor

a = saturation factor, as follows:

Phase-to-Ground Exposures

$V_{Peak} = T_{L-G}V_{L-G}\sqrt{2}$	635 kV or less	635.1 to 915 kV	915.1 to 1,050 kV	More than 1,050 kV
a	0	$(V_{Peak}-635)/140{,}000$	$(V_{Peak}-645)/135{,}000$	$(V_{Peak}-675)/125{,}000$

Phase-to-Phase Exposures [3]

$V_{Peak} = (1.35T_{L-G} + 0.45)V_{L-G}\sqrt{2}$	630 kV or less	630.1 to 848 kV	848.1 to 1,131 kV	1,131.1 to 1,485 kV	More than 1,485 kV
a	0	$(V_{Peak}-630)/155{,}000$	$(V_{Peak}-633.6)/152{,}207$	$(V_{Peak}-628)/153{,}846$	$(V_{Peak}-350.5)/203{,}666$

[1] Employers may use the minimum approach distances in Table RR-5. If the worksite is at an elevation of more than 900 meters (3,000 feet), see footnote 1 to Table RR-5.

[2] Employers may use the minimum approach distances in Table RR-6, except that the employer may not use the minimum approach distances in Table RR-6 for phase-to-phase exposures if an insulated tool spans the gap or if any large conductive object is in the gap. If the worksite is at an elevation of more than 900 meters (3,000 feet), see footnote 1 to Table RR-6. Employers may use the minimum approach distances in Table 6 through Table 13 in Appendix B to Division 2/RR, which calculated MAD for various values of T, provided the employer follows the notes to those tables.

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

TABLE RR-3-ELECTRICAL COMPONENT OF THE MINIMUM APPROACH DISTANCE AT 5.1 TO 72.5 KV
[D; In meters]

Nominal voltage (kV) phase-to-phase	Phase-to-ground exposure D (m)	Phase-to-phase exposure D (m)
5.1 to 15.0	0.04	0.07
15.1 to 36.0	0.16	0.28
36.1 to 46.0	0.23	0.37
46.1 to 72.5	0.39	0.59

TABLE RR-4-ALTITUDE CORRECTION FACTOR

Altitude above sea level (m)	*A*
0 to 900	1.00
901 to 1,200	1.02
1,201 to 1,500	1.05
1,501 to 1,800	1.08
1,801 to 2,100	1.11
2,101 to 2,400	1.14
2,401 to 2,700	1.17
2,701 to 3,000	1.20
3,001 to 3,600	1.25
3,601 to 4,200	1.30
4,201 to 4,800	1.35
4,801 to 5,400	1.39
5,401 to 6,000	1.44

TABLE RR-5-ALTERNATIVE MINIMUM APPROACH DISTANCES FOR VOLTAGES OF 72.5 KV AND LESS [1]
[In meters or feet and inches]

Nominal voltage (kV) phase-to-phase	Distance			
	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
0.50 to 0.300 [2]	Avoid Contact		Avoid Contact	
0.301 to 0.750 [2]	0.33	1.09	0.33	1.09
0.751 to 5.0	0.63	2.07	0.63	2.07
5.1 to 15.0	0.65	2.14	0.68	2.24
15.1 to 36.0	0.77	2.53	0.89	2.92
36.1 to 46.0	0.84	2.76	0.98	3.22
46.1 to 72.5	1.00	3.29	1.20	3.94

[1] Employers may use the minimum approach distances in this table provided the worksite is at an elevation of 900 meters (3,000 feet) or less. If employees will be working at elevations greater than 900 meters (3,000 feet) above mean sea level, the employer must determine minimum approach distances by multiplying the distances in this table by the correction factor in Table R-5 corresponding to the altitude of the work.

[2] For single-phase systems, use voltage-to-ground.

TABLE RR-6-ALTERNATIVE MINIMUM APPROACH DISTANCES FOR VOLTAGES OF MORE THAN 72.5 KV [1 2 3]
[In meters or feet and inches]

Voltage range phase to phase (kV)	Phase-to-ground	Phase-to-phase

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

[1] Employers may use the minimum approach distances in this table provided the worksite is at an elevation of 900 meters (3,000 feet) or less. If employees will be working at elevations greater than 900 meters (3,000 feet) above mean sea level, the employer must determine minimum approach distances by multiplying the distances in this table by the correction factor in Table RR-4 corresponding to the altitude of the work.

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

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

TABLE RR-7-DC LIVE-LINE MINIMUM APPROACH DISTANCE WITH OVERVOLTAGE FACTOR [1]
[In meters]

Maximum anticipated per-unit transient overvoltage	Distance (m) maximum line-to-ground voltage (kV)				
	250	400	500	600	750
1.5 or less	1.12	1.60	2.06	2.62	3.61
1.6	1.17	1.69	2.24	2.86	3.98

1.7	1.23	1.82	2.42	3.12	4.37
1.8	1.28	1.95	2.62	3.39	4.79

[1] The distances specified in this table are for air, and live-line tool conditions. If employees will be working at elevations greater than 900 meters (3,000 feet) above mean sea level, the employer must determine minimum approach distances by multiplying the distances in this table by the correction factor in Table RR-4 corresponding to the altitude of the work.

TABLE RR-8-ASSUMED MAXIMUM PER-UNIT TRANSIENT OVERVOLTAGE

Voltage range (kV)	Type of current (ac or dc)	Assumed maximum per-unit transient overvoltage
72.6 to 420.0	ac	3.5
420.1 to 550.0	ac	3.0
550.1 to 800.0	ac	2.5
250 to 750	dc	1.8

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2312 Deenergizing lines and equipment for employee protection.

(1) Application. This rule applies to the deenergizing of transmission and distribution lines and equipment for the purpose of protecting employees. See 437-002-2303 Hazardous Energy Control, Division 2/RR, for requirements on the control of hazardous energy sources used in the generation of electric energy. Conductors and parts of electric equipment that have been deenergized under procedures other than those required by 437-002-2303, as applicable, must be treated as energized.

(2) General.

(a) If a system operator is in charge of the lines or equipment and their means of disconnection, the employer must designate one employee in the crew to be in charge of the clearance and must comply with all of the requirements of paragraph (3) of this rule in the order specified.

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

(c) 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 (3)(b), (3)(d), and (3)(f) of this rule do not apply. Additionally, the employer does not need to use the tags required by the remaining provisions of paragraph (3) of this rule.

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

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

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

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

(3) Deenergizing lines and equipment

(a) The employee that the employer designates pursuant to paragraph (2) of this rule as being in charge of the clearance must make a request of the system operator to deenergize the particular section of line or equipment. The designated employee becomes the employee in charge (as this term is used in paragraph (3) of this rule) and is responsible for the clearance.

(b) The circuit or equipment must be considered as energized until notification from the system operator to the contrary is received.

(c) The system operator must obtain the name of the person requesting clearance and be assured that the person is qualified to receive such clearance.

(d) The person requesting the clearance must state exactly what circuit or equipment they want de-energized and the reason.

(e) The system operator must repeat the request for clearance and be certain that the request is fully understood.

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

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

(h) The employer need not use the tags mentioned in paragraphs (3)(f) and (3)(g) of this rule on a network protector for work on the primary feeder for the network protector's associated network transformer when the employer can demonstrate all of the following conditions:

> (A) Every network protector is maintained so that it will immediately trip open if closed when a primary conductor is deenergized;
>
> (B) Employees cannot manually place any network protector in a closed position without the use of tools, and any manual override position is blocked, locked, or otherwise disabled; and
>
> (C) The employer has procedures for manually overriding any network protector that incorporate provisions for determining, before anyone places a network protector in a closed position, that: The line connected to the network protector is not deenergized for the protection of any employee working on the line; and (if the line connected to the network protector is not deenergized for the protection of any employee working on the line) the primary conductors for the network protector are energized.

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

(j) After the applicable requirements in paragraphs (3)(a) through (3)(i) of this section have been followed and the system operator gives a clearance to the employee in charge, the employer must ensure that the lines and equipment are deenergized by testing the lines and equipment to be worked with a device designed to detect voltage.

(k) The employer must ensure the installation of protective grounds as required by 437-002-2313 Grounding for the protection of employees, Division 2/RR.

(l) After the applicable requirements of paragraphs (3)(a) through (3)(k) of this rule have been followed, the lines and equipment involved may be considered deenergized.

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

(n) To release a clearance, the employee in charge must:

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

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

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

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

(o) Only the employee in charge who requested the clearance may release the clearance, unless the employer transfers responsibility under paragraph (3)(m) of this rule.

(p) No one may remove tags without the release of the associated clearance as specified under paragraphs (3)(n) and (3)(o) of this rule.

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

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2313 Grounding for the protection of employees.

(1) Application. 437-002-2313 applies to grounding of generation, transmission, and distribution lines and equipment for the purpose of protecting employees. Paragraph (4) of this rule also applies to protective grounding of other equipment as required elsewhere in Division 2/RR.

(2) General. For any employee to work transmission and distribution lines or equipment as deenergized, the employer must ensure that the lines or equipment are deenergized under the provisions of 437-002-2312 and must ensure proper grounding of the lines or equipment as specified in paragraphs (3) through (8) below. However, if the employer can demonstrate that installation of a ground is impracticable or that the conditions resulting from the installation of a ground would present greater hazards to employees than working without grounds, the lines and equipment may be treated as deenergized provided that the employer establishes that all of the following conditions apply:

(a) The employer ensures that the lines and equipment are deenergized under the provisions of 437-002-2312 Deenergizing lines and equipment for employee protection, Division 2/RR.

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

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

(3) Equipotential zone. Temporary protective grounds must be placed at such locations and arranged to will prevent each employee from being exposed to hazardous differences in electric potential.

Note to paragraph (3): Appendix C to Division 2/RR contains guidelines for establishing the equipotential zone required by this paragraph. Oregon OSHA will deem grounding practices meeting these guidelines as complying with paragraph (3) of this rule.

(4) Protective grounding equipment.

(a) Protective grounding equipment must be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.

(b) Protective grounding equipment must have an ampacity greater than or equal to that of No. 2 AWG copper.

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

(d) While working on circuits deenergized under clearance conditions with multi-phase lines, shorts and grounds must be established at the lowest impedance available. Employees may perform work on one phase of a multi-phase line after establishing an equipotential zone that includes the phase being directly worked on. The phases outside the equipotential zone are to be treated as energized with minimum approach distance observed, unless they become part of the equipotential zone.

Note to paragraph (4): American Society for Testing and Materials Standard Specifications for Temporary Protective Grounds to Be Used on De-Energized Electric Power Lines and Equipment, ASTM F855-09, contains guidelines for protective grounding equipment. The Institute of Electrical Engineers Guide for Protective Grounding of Power Lines, IEEE Std 1048-2003, contains guidelines for selecting and installing protective grounding equipment.

(5) Testing. The employer must ensure that, unless a previously installed ground is present, employees test lines and equipment and verify the absence of nominal voltage before employees install any ground on those lines or that equipment.

(6) Grounding must be verified if an employee requests it.

(7) Connecting and removing grounds.

(a) The employer must ensure that, when an employee attaches a ground to a line or to equipment, the employee attaches the ground-end connection first and then attaches the other end by means of a live-line tool. For lines or equipment operating at 600 volts or less, the employer may permit the employee to use insulating equipment other than a live-line tool if the employer ensures that the line or equipment is not energized at the time the ground is connected or if the employer can demonstrate that each employee is protected from hazards that may develop if the line or equipment is energized.

(b) The employer must ensure that, when an employee removes a ground, the employee removes the grounding device from the line or equipment using a live-line tool before they remove the ground-end connection. For lines or equipment operating at 600 volts or less, the employer may permit the employee to use insulating equipment other than a live-line tool if the employer ensures that the line or equipment is not energized at the time the ground is disconnected or if the employer can demonstrate that each employee is protected from hazards that may develop if the line or equipment is energized.

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

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

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2314 Testing and test facilities.

(1) Application. 437-002-2314 provides for safe work practices for high-voltage and high-power testing performed in laboratories, shops, and substations, and in the field and on electric transmission and distribution lines and equipment. It applies only to testing involving interim measurements using high voltage, high power, or combinations of high voltage and high power, and not to testing involving continuous measurements as in routine metering, relaying, and normal line work.

Note to paragraph (1): Oregon OSHA considers routine inspection and maintenance measurements made by qualified employees to be routine line work not included in the scope of 437-002-2314, provided that the hazards related to the use of intrinsic high-voltage or high-power sources require only the normal precautions associated with routine work specified in the other paragraphs of this rule. Two typical examples of such excluded test work procedures are "phasing-out" testing and testing for a "no-voltage" condition.

(2) General requirements.

(a) The employer must 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 must include, as a minimum, test area safeguarding, grounding, the safe use of measuring and control circuits, and a means providing for periodic safety checks of field test areas.

(b) The employer must ensure that each employee, upon initial assignment to the test area, receives training in safe work practices, with retraining provided as required by 437-002-2300(2).

(3) Safeguarding of test areas.

(a)The employer must provide safeguarding within test areas to control access to test equipment or to apparatus under test that could become energized as part of the testing by either direct or inductive coupling and to prevent accidental employee contact with energized parts.

(b) The employer must guard permanent test areas with walls, fences, or other barriers designed to keep employees out of the test areas.

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

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

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

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

(d) The employer must ensure the removal of the safeguards required by paragraph (3)(c) of this rule when employees no longer need the protection afforded by the safeguards.

(4) Grounding practices.

(a) The employer must establish and implement safe grounding practices for the test facility.

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

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

(b) The employer must ensure either that visible grounds are applied automatically, or that employees using properly insulated tools manually apply visible grounds, to the high-voltage circuits after they are deenergized and before any employee performs work on the circuit or on the item or apparatus under test. Common ground connections must be solidly connected to the test equipment and the apparatus under test.

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

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

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

Note to paragraph (4)(c)(B): See Appendix C to Division 2/RR for information on measures that employers can take to protect employees from hazardous step and touch potentials.

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

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

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

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

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

(5) Control and measuring circuits.

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

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

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

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

(6) Safety check.

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

(b) The test operator in charge must conduct these routine safety checks before each series of tests and must verify at least the following conditions:

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

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

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

(D) Ground connections are clearly identifiable;

(E) Personal protective equipment is provided and used as required by Division 2/I, Division 3/E, and Division 2/RR; and

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

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2315 Mechanical equipment.

(1) General requirements.

Note to 437-002-2315: For employers engaged in construction activities, mechanical equipment must be operated in accordance with applicable requirements in Division 3, including subdivisions N, O, and CC of Division 3, except that 1926.600(a)(6) does not apply to operations performed by qualified employees.

(a) The critical safety components of mechanical elevating and rotating equipment must receive a thorough visual inspection before use on each shift.

Note to paragraph (1)(a): Critical safety components of mechanical elevating and rotating equipment are components for which failure would result in free fall or free rotation of the boom.

(b) No motor vehicle or earthmoving or compacting 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.

(c) 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, must have rollover protective structures that meet the requirements of Division 3/W.

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

(2) Outriggers.

(a) Mobile equipment, if provided with outriggers, must be operated with the outriggers extended and firmly set, except as provided in paragraph (2)(c) of this rule.

(b) Outriggers may not be extended or retracted outside of the clear view of the operator unless all employees are outside the range of possible equipment motion.

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

(3) Applied loads. Mechanical equipment used to lift or move lines or other material must be used within its maximum load rating and other design limitations for the conditions under which the mechanical equipment is being used.

(4) Operations near energized lines or equipment.

(a) Mechanical equipment must be operated so that the minimum approach distances from exposed energized lines and equipment, established by the employer under paragraph (3)(a) of 437-002-2311, are maintained. However, the insulated portion of an aerial lift operated by a qualified employee in the lift is exempt from this requirement if the applicable minimum approach distance is maintained between the uninsulated portions of the aerial lift and exposed objects having a different electrical potential.

(b) A designated employee other than the equipment operator must observe the approach distance to exposed lines and equipment and provide timely warnings before the minimum approach distance required by paragraph (4)(a) of this rule is reached, unless the employer can demonstrate that the operator can accurately maintain the minimum approach distance.

(c) Aerial lifts must have dual controls (lower and upper) as follows:

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

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

(C) Controls must be placed and guarded so that the equipment cannot be activated by inadvertent contact by the operator, tools, equipment, lines, or foreign objects.

(d) If, during operation of the mechanical equipment, that equipment could become energized, the operation also must comply with at least one of paragraphs (4)(d)(A) through (4)(d)(C) of this rule.

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

(B) The mechanical equipment must be insulated for the voltage involved. The mechanical equipment must be positioned so that its uninsulated portions cannot approach the energized lines or equipment any closer than the minimum approach distances, established by the employer under paragraph (3)(a) of 437-002-2311.

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

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

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

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

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

Note to paragraph (4)(d)(C): Appendix C to Division 2/RR contains information on hazardous step and touch potentials and on methods of protecting employees from hazards resulting from such potentials.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2316 Overhead lines.

(1) General. This paragraph provides additional requirements for work performed on or near overhead lines and equipment.

(a) The employer must determine if elevated structures such as poles or towers are capable of withstanding the additional or unbalanced stresses of climbing or equipment. If the pole or other structure cannot withstand the expected loads, the employer must brace or otherwise support the pole or structure to prevent failure.

Note to paragraph (1)(a): Appendix D to Division 2/RR contains test methods that employers can use to determine whether a wood pole is capable of sustaining the forces imposed by an employee climbing the pole. This paragraph also requires the employer to determine that the pole can sustain all other forces imposed by the work employees will perform.

(b) When a pole is set, moved, or removed near an exposed energized overhead conductor, the pole may not contact the conductor.

(c) Raising poles, towers, or fixtures close to high voltage conductors must be done under the supervision of a worker qualified for this work.

(d) Conductive rigging (wire rope) may not be used to raise poles, transformers, and other equipment except when such rigging is below, protected, or at a sufficient distance from energized high voltage conductors to prevent hazardous contact.

(e) When a pole is set, moved, or removed near an exposed energized overhead conductor, the employer must 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 their body.

(f) To protect employees from falling into holes used for placing poles, the employer must physically guard the holes, or ensure that employees attend the holes, whenever anyone is working nearby.

(g) Suitable guards and barriers must be erected so that workers or tools and equipment will not fall into or accidentally contact energized conductors or equipment.

(h) Materials and tools other than belt tools for which the body belt is designed:

(A) Must be raised or lowered by means of a suitable container or handline.

(B) May not be thrown to or from employees working on poles or structures. When field conditions prevent the use of a handline or alternative method from being done safely, a designated drop zone must be established. Clear communication must occur to prevent employees from entering the zone while material is being dropped in a controlled manner.

(2) Installing and removing overhead lines. The following provisions apply to the installation and removal of overhead conductors or cable (overhead lines).

(a) When lines that employees are installing or removing can contact energized parts, the employer must use the tension-stringing method, barriers, or other equivalent measures to minimize the possibility that conductors and cables the employees are installing or removing will contact energized power lines or equipment.

(b) For conductors, cables, and pulling and tensioning equipment, the employer must provide the protective measures required by 437-002-2315 (4)(d) when employees are installing or removing a conductor or cable close enough to energized conductors that any of the following failures could energize the pulling or tensioning equipment or the conductor or cable being installed or removed:

(A) Failure of the pulling or tensioning equipment,

(B) Failure of the conductor or cable being pulled, or

(C) Failure of the previously installed lines or equipment.

(c) If the conductors that employees are installing or removing cross over energized conductors in excess of 600 volts and if the design of the circuit interrupting devices protecting the lines so permits, the employer must render inoperable the automatic-reclosing feature of these devices.

(d) Before employees install lines parallel to existing energized lines, the employer must make a determination of the approximate voltage to be induced in the new lines, or work must proceed on the assumption that the induced voltage is hazardous. Unless the employer can demonstrate that the lines that employees are installing are not subject to the induction of a hazardous voltage or unless the lines are treated as energized, temporary protective grounds must be placed at such locations and arranged in such a manner that the employer can demonstrate will prevent exposure of each employee to hazardous differences in electric potential.

Note 1 to paragraph (2)(d): If the employer takes no precautions to protect employees from hazards associated with involuntary reactions from electric shock, a hazard exists if the induced voltage is sufficient to pass a current of 1 milliampere through a 500-ohm resistor. If the employer protects employees from injury due to involuntary reactions from electric shock, a hazard exists if the resultant current would be more than 6 milliamperes.

Note 2 to paragraph (2)(d): Appendix C to Division 2/RR rule contains guidelines for protecting employees from hazardous differences in electric potential as required by this paragraph.

(e) Conductors being strung must not be allowed to slack enough to be in reach of traffic or pedestrians, unless guarded by flaggers or other suitable safeguards.

(f) Reel-handling equipment, including pulling and tensioning devices, must be in safe operating condition and must be leveled and aligned.

(g) When stringing or removing conductors under tension, sleeves must not be pulled through the bull wheel or the puller on the tension machine unless appropriate safeguards are taken.

(h) A qualified employee, or an experienced person under the supervision of a qualified employee, must be placed in charge of the reels as the reel tender.

(i) Reel handling equipment, including pulling, braking, and sagging equipment must be firmly anchored or secured during operations.

(j) The employer must ensure that employees do not exceed load ratings of stringing lines, pulling lines, conductor grips, load-bearing hardware and accessories, rigging, and hoists.

(k) When replacing a conductor with a new or larger conductor, the conductor being removed may not be used to pull in the new one unless the one being removed has been carefully inspected for its entire length and then adjudged to have adequate strength.

(l) The employer must repair or replace defective pulling lines and accessories.

(m) Each pull must be snubbed or dead ended at both ends before subsequent pulls.

(n) The employer must ensure that employees do not use conductor grips on wire rope unless the manufacturer specifically designed the grip for this application.

(o) The employer must ensure that employees maintain reliable communications, through two-way radios or other equivalent means, between the reel tender and the pulling rig operator.

(p) Employees may operate the pulling rig only when it is safe to do so.
Note to paragraph (2)(p): Examples of unsafe conditions include: employees in locations prohibited by paragraph (2)(q) of this rule, conductor and pulling line hang-ups, and slipping of the conductor grip.

(q) While a power-driven device is pulling the conductor or pulling line and the conductor or pulling line is in motion, the employer must ensure that employees are not directly under overhead operations or on the cross arm, except as necessary for the employees to guide the stringing sock or board over or through the stringing sheave.

(3) Live-line bare-hand work is prohibited.

(4) Towers and structures. The following requirements apply to work performed on towers or other structures that support overhead lines.

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

(b) The employer must ensure that employees use tag lines or other similar devices to maintain control of tower rules being raised or positioned, unless the employer can demonstrate that the use of such devices would create a greater hazard to employees.

(c) The employer must ensure that employees do not detach the loadline from a member or rule until they safely secure the load.

(d) The employer must ensure that, except during emergency restoration procedures, employees discontinue work when adverse weather conditions would make the work hazardous in spite of the work practices required by this rule.

Note to paragraph (4)(d): Thunderstorms in the vicinity, high winds, snow storms, and ice storms are examples of adverse weather conditions that make this work too hazardous to perform even after the employer implements the work practices required by this rule.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2317 Line-clearance tree trimming.

This rule provides additional requirements for line-clearance tree trimming and for equipment used in this type of work.

(1) Electrical hazards. This paragraph does not apply to qualified employees.

(a) Before an employee climbs, enters, or works around any tree, a determination must be made of the nominal voltage of electric power lines posing a hazard to employees. However, a determination of the maximum nominal voltage to which an employee will be exposed may be made instead, if all lines are considered as energized at this maximum voltage.

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

(A) If a line-clearance tree trimmer is to approach more closely than 3.05 meters (10 feet) to any conductor or electric apparatus energized at more than 600 volts or

(B) If branches or limbs being removed are closer to lines energized at more than 600 volts than the distances listed in Table RR-4, Table RR-5, Table RR-6, and Table RR-7 or

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

(c) Line-clearance tree trimmers must maintain the minimum approach distances from energized conductors given in Table RR-4, Table RR-5, Table RR-6, and Table RR-7.

(d) Branches that are contacting exposed energized conductors or equipment, or that are within the distances specified in Table RR-4 Table RR-5, Table RR-6, and Table RR-7 may be removed only through the use of insulating equipment.

Note to paragraph (1)(d): A tool constructed of a material that the employer can demonstrate has insulating qualities meeting paragraph (3) of 437-002-2309 is considered as insulated under paragraph (1)(d) of this rule if the tool is clean and dry.

(e) Ladders, platforms, and aerial devices may not be brought closer to an energized part than the distances listed in Table RR-4, Table RR-5, Table RR-6, and Table RR-7.

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

Note to paragraph (1)(f): 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 too hazardous to perform safely.

(2) Brush chippers.

(a) Brush chippers must be equipped with a locking device in the ignition system.

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

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

(d) Trailer chippers detached from trucks must be chocked or otherwise secured.

(e) Each employee in the immediate area of an operating chipper feed table must wear personal protective equipment as required Division 2/I.

(3) Sprayers and related equipment.

(a) Walking and working surfaces of sprayers and related equipment must be covered with slip-resistant material. If slipping hazards cannot be eliminated, slip-resistant footwear or handrails and stair rails meeting the requirements of Division 2/D may be used instead of slip-resistant material.

(b) Equipment on which employees stand to spray while the vehicle is in motion must be equipped with guardrails around the working area. The guardrail must be constructed in accordance with Division 2/D.

(4) Stump cutters.

(a) Stump cutters must be equipped with enclosures or guards to protect employees.

(b) Each employee in the immediate area of stump grinding operations including the stump cutter operator) must wear personal protective equipment as required by Division 2/I.

(5) Gas powered saws. Gas powered saw operations must meet the requirements of 437-007-0405 Chain Saws, Division 7; and the following:

(a) Each power saw weighing more than 6.8 kilograms (15 pounds, service weight) that is used in trees must 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.

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

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

(d) A power saw must be started on the ground or where it is otherwise firmly supported. Drop starting of saws over 6.8 kilograms (15 pounds), other than chain saws, is permitted outside of the bucket of an aerial lift only if the area below the lift is clear of personnel. Drop starting chain saws is prohibited.

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

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

(g) Power saw engines must 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.

(a) While a backpack power unit is running, no one other than the operator may be within 3.05 meters (10 feet) of the cutting head of a brush saw.

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

(c) Backpack power unit engines must 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.

(a) Climbing ropes must be used by employees working aloft in trees. These ropes must have a minimum diameter of 12 millimeters (0.5 inch) with a minimum breaking strength of 10.2 kilonewtons (2,300 pounds). Synthetic rope must have elasticity of not more than 7 percent.

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

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

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

(e) Rope ends must be secured to prevent their unraveling.

(f) Climbing rope may not be repaired by splicing.

(g) 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 must be tied in with a climbing rope and safety saddle when the employee is working above the ground in a tree, except when ascending into or descending from the tree.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2318 Communication facilities.

(1) Microwave transmission.

(a) The employer must ensure that no employee looks into an open waveguide or antenna connected to an energized microwave source.

(b) If the electromagnetic-radiation level within an accessible area associated with microwave communications systems exceeds the radiation-protection guide specified by 1910.97(a)(2), the employer must post the area with warning signs containing the warning symbol described in 1910.97(a)(3). The lower half of the warning symbol must 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."

(c) When an employee works in an area where the electromagnetic radiation could exceed the radiation protection guide, the employer must 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. The employer must ensure that employees perform power-line carrier work, including work on equipment used for coupling carrier current to power line conductors, in accordance with the requirements of Division 2/RR pertaining to work on energized lines.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2319 Underground electrical installations.

This rule provides additional requirements for work on underground electrical installations.

(1) Access. The employer must ensure that employees use a ladder or other climbing device to enter and exit a manhole or subsurface vault exceeding 1.22 meters (4 feet) 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.

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

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

(3) Attendants for manholes and vaults.

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

(b) Occasionally, the employee on the surface may briefly enter a manhole or vault to provide nonemergency assistance.

Note 1 to paragraph (3)(b): 437-002-2304(7) of Division 2/RR may also require an attendant and does not permit this attendant to enter the manhole or vault.

Note 2 to paragraph (3)(b): 437-002-2311(1)(b) of Division 2/RR requires employees entering manholes or vaults containing unguarded, uninsulated energized lines or parts of electric equipment operating at 50 volts or more to be qualified.

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

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

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

(5) All primary cables must be permanently and plainly identified by tags or other methods at both ends.

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

(7) Moving cables. Except when paragraph (8)(b) of this rule permits employees to perform work that could cause a fault in an energized cable in a manhole or vault, the employer must ensure that employees inspect energized cables to be moved for abnormalities.

(8) Protection against faults.

> (a) Where a cable in a manhole or vault has one or more abnormalities that could lead to a fault or be an indication of an impending fault, the employer must deenergize the cable with the abnormality before any employee may work in the manhole or vault, 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 or vault provided the employer protects them from the possible effects of a failure using shields or other devices that are capable of containing the adverse effects of a fault. The employer must treat the following abnormalities as indications of impending faults unless the employer can demonstrate that the conditions could not lead to a fault: Oil or compound leaking from cable or joints, broken cable sheaths or joint sleeves, hot localized surface temperatures of cables or joints, or joints swollen beyond normal tolerance.
>
> (b) If the work employees will perform in a manhole or vault could cause a fault in a cable, the employer must deenergize that cable before any employee works in the manhole or vault, 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 or vault provided the employer protects them from the possible effects of a failure using shields or other devices that are capable of containing the adverse effects of a fault.

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

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2320 Substations.

This paragraph provides additional requirements for substations and for work performed in them.

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

Note to paragraph (1): American National Standard: National Electrical Safety Code, ANSI/IEEE C2-2012 contains guidelines for the dimensions of access and working space about electric equipment in substations. Installations meeting the ANSI provisions comply with paragraph (u)(1) of this rule. Oregon OSHA will determine whether an installation that does not conform to this ANSI standard complies with paragraph (1) of this rule based on the following criteria:

> Whether the installation conforms to the edition of ANSI C2 that was in effect when the installation was made.
>
> Whether the configuration of the installation enables employees to maintain the minimum approach distances, established by the employer under paragraph (3)(a) of 437-002-2311, while the employees are working on exposed, energized parts, and
>
> Whether the precautions taken when employees perform work on the installation provide protection equivalent to the protection provided by access and working space meeting ANSI/IEEE C2-2012.

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

(3) Substation fences. Conductive fences around substations must be grounded. When a substation fence is expanded or a section is removed, fence sections must be isolated, grounded, or bonded as necessary to protect employees from hazardous differences in electric potential.

Note to paragraph (3): IEEE Std 80-2000, IEEE Guide for Safety in AC Substation Grounding, contains guidelines for protection against hazardous differences in electric potential.

(4) Guarding of rooms and other spaces containing electric supply equipment.

> (a) Rooms and other spaces in which electric supply lines or equipment are installed must meet the requirements of paragraphs (4)(a) through (4)(e) of this rule under the following conditions:
>
> > (A) If exposed live parts operating at 50 to 150 volts to ground are within 2.4 meters (8 feet) of the ground or other working surface inside the room or other space,
> >
> > (B) If live parts operating at 151 to 600 volts to ground and located within 2.4 meters (8 feet) of the ground or other working surface inside the room or other space are guarded only by location, as permitted under paragraph (5)(a) of this rule, or

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

(i) 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

(ii) The live parts are installed at a height, above ground and any other working surface, that provides protection at the voltage on the live parts corresponding to the protection provided by a 2.4-meter (8-foot) height at 50 volts.

(b) Fences, screens, partitions, or walls must enclose the rooms and other spaces so as to minimize the possibility that unqualified persons will enter.

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

(d) The employer must display signs at entrances to the rooms and other spaces warning unqualified persons to keep out.

(e) The employer must keep each entrance to a room or other space locked, unless the entrance is under the observation of a person who is attending the room or other space for the purpose of preventing unqualified employees from entering.

(5) Guarding of energized parts.

(a) The employer must provide guards 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 clearance (horizontal, vertical, or both) to minimize the possibility of accidental employee contact.

Note to paragraph (5)(a): American National Standard: National Electrical Safety Code, ANSI/IEEE C2-2002 contains guidelines for the dimensions of clearance distances about electric equipment in substations. Installations meeting the ANSI provisions comply with paragraph (5)(a) of this rule. Oregon OSHA will determine whether an installation that does not conform to this ANSI standard complies with paragraph (5)(a) of this rule based on the following criteria:

Whether the installation conforms to the edition of ANSI C2 that was in effect when the installation was made,

Whether each employee is isolated from energized parts at the point of closest approach; and

Whether the precautions taken when employees perform work on the installation provide protection equivalent to the protection provided by horizontal and vertical clearances meeting ANSI/IEEE C2-2002.

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

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

(d) Proper identification and warning signs must be posted at all entrances to battery rooms or compartments.

(6) Substation entry.

(a) Upon entering an attended substation, each employee, other than employees regularly working in the station, must report their presence to the employee in charge of substation activities to receive information on special system conditions affecting employee safety.

(b) The job briefing required by 437-002-2302 Job Briefing, Division 2/RR; must cover information on special system conditions affecting employee safety, including the location of energized equipment in or adjacent to the work area and the limits of any deenergized work area. Job briefings apply equally to unattended and attended substations and to employees already working in a substation and employees who enter a substation.

(c) A qualified safety watch must be provided for all other work being performed in any energized substation yard except when the work is separated from all energized equipment by a barrier.

(d) Qualified nonelectrical workers will be allowed to work in substations without barriers and without a safety watch if all the following conditions are observed:

(A) Permission to enter must be obtained from the substation operator or other authorized person.

(B) Each qualified nonelectrical worker must be trained and competent as required by 437-002-2300(2)(b) Training, of Division 2/RR, and must have demonstrated proficiencies in the work practices involved as required by 437-002-2300 (2)(h) Training, Division 2/RR.

Note: Employees who have not demonstrated proficiency in the work practices involved are considered to be undergoing on-the-job training and must be under the direct supervision of a qualified employee.

(C) The worker must not work off the ground without the specific approval of the person responsible for control of entry except to operate such equipment as light motor vehicles, which have no equipment or loads that can project above the cab.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2321 Power generation installations.

This rule provides additional requirements and related work practices for power generating plants.

(1) Interlocks and other safety devices.

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

(b) 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 must 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. The employer must provide and maintain sufficient access and working space around electric equipment to permit ready and safe operation and maintenance.

Note to paragraph (3) of this rule: American National Standard: National Electrical Safety Code, ANSI/IEEE C2-2012 contains guidelines for the dimensions of access and working space about electric equipment in substations. Installations meeting the ANSI provisions comply with paragraph (3) of this rule. Oregon OSHA will determine whether an installation that does not conform to this ANSI standard complies with paragraph (3) of this rule based on the following criteria:

Whether the installation conforms to the edition of ANSI C2 that was in effect when the installation was made;

Whether the configuration of the installation enables employees to maintain the minimum approach distances, established by the employer under paragraph (3)(a) of this section, while the employees are working on exposed, energized parts, and;

Whether the precautions taken when employees perform work on the installation provide protection equivalent to the protection provided by access and working space meeting ANSI/IEEE C2-2012.

(4) Guarding of rooms and other spaces containing electric supply equipment.

(a) Rooms and other spaces in which electric supply lines or equipment are installed must meet the requirements of paragraphs (4)(b) through (4)(e) of this rule under the following conditions:

(A) If exposed live parts operating at 50 to 150 volts to ground are within 2.4 meters (8 feet) of the ground or other working surface inside the room or other space,

(B) If live parts operating at 151 to 600 volts to ground and located within 2.4 meters (8 feet) of the ground or other working surface inside the room or other space are guarded only by location, as permitted under paragraph (5)(a) of this rule, or

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

(i) 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

(ii) The live parts are installed at a height, above ground and any other working surface, that provides protection at the voltage on the live parts corresponding to the protection provided by a 2.4-meter (8-foot) height at 50 volts.

(b) Fences, screens, partitions, or walls must enclose the rooms and other spaces so as to minimize the possibility that unqualified persons will enter.

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

(d) The employer must display signs at entrances to the rooms and other spaces warning unqualified persons to keep out.

(e) The employer must keep each entrance to a room or other space locked, unless the entrance is under the observation of a person who is attending the room or other space for the purpose of preventing unqualified employees from entering.

(5) Guarding of energized parts.

(a) The employer must provide guards 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 clearance (horizontal, vertical, or both) to minimize the possibility of accidental employee contact.

Note to paragraph (5)(a): American National Standard: National Electrical Safety Code, ANSI/IEEE C2-2002 contains guidelines for the dimensions of clearance distances about electric equipment in substations. Installations meeting the ANSI provisions comply with paragraph (5)(a) of this rule. Oregon OSHA will determine whether an installation that does not conform to this ANSI standard complies with paragraph (5)(a) of this rule based on the following criteria:

Whether the installation conforms to the edition of ANSI C2 that was in effect when the installation was made;

Whether each employee is isolated from energized parts at the point of closest approach; and

Whether the precautions taken when employees perform work on the installation provide protection equivalent to the protection provided by horizontal and vertical clearances meeting ANSI/IEEE C2-2002.

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

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

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

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

(b) Where it is necessary for employees to work near tube ends during cleaning, shielding must 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:

(a) Areas where chemical cleaning is in progress must 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 must 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.

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

(c) There must be ready access to water or showers for emergency use.

Note to paragraph (7)(c): See 1910.141 and 437-002-0141 for requirements that apply to the water supply and to washing facilities.

(d) Employees in restricted areas must wear protective equipment meeting the requirements of Division 2/I and including, but not limited to, protective clothing, boots, goggles, and gloves.

(8) Chlorine systems.

(a) Chlorine system enclosures must be posted with signs restricting entry and warning of the hazard to health and the hazards of fire and explosion.
Note to paragraph (8)(a): See Division 2/Z for requirements necessary to protect the health of employees from the effects of chlorine.

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

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

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

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

(9) Boilers.

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

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

(10) Turbine generators.

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

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

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

(11) Coal and ash handling.

(a) Only designated persons may operate railroad equipment.

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

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

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

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

(f) An emergency means of stopping dump operations must be provided at railcar dumps.

(g) The employer must 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 (11)(h) through (11)(l) of this rule.

(h) 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 rule.

(i) A conveyor that 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.

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

(k) 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 must 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 must be easily identifiable in the immediate vicinity of such locations.
>
> (B) An emergency stop device must act directly on the control of the conveyor involved and may not depend on the stopping of any other equipment.
>
> (C) Emergency stop devices must be installed so that they cannot be overridden from other locations.

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

Note to paragraph (11)(l): Locations that are hazardous because of the presence of combustible dust are classified as Class II hazardous locations. See 1910.307.

(m) 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.

(n) An employee entering a bunker or silo to dislodge the contents must wear a body harness with lifeline attached. The lifeline must be secured to a fixed support outside the bunker and must 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 must be warned and must vacate such dangerous areas before water flow changes are made.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2322 Special conditions.

(1) Capacitors. The following additional requirements apply to work on capacitors and on lines connected to capacitors.

Note to paragraph (1): See 437-002-2312 Deenergizing Lines and Equipment for Employee Protection; and 437-002-2313 Grounding for the Protection of Employees, of Division 2/RR, for requirements pertaining to the deenergizing and grounding of capacitor installations.

(a) Before employees work on capacitors, the employer must disconnect the capacitors from energized sources and short circuit the capacitors. The employer must ensure that the employee short circuiting the capacitors waits at least 5 minutes from the time of disconnection before applying the short circuit.

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

(c) The employer must short circuit any line connected to capacitors before the line is treated as deenergized.

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

(3) Series streetlighting.

(a) If the open-circuit voltage exceeds 600 volts, the employer must ensure that employees work on series streetlighting circuits in accordance with 437-002-2316 Overhead Lines; and 437-002-2319 Underground Electrical Installations, of Division 2/RR, as appropriate.

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

(4) Illumination. The employer must provide sufficient illumination to enable the employee to perform the work safely.

(5) Protection against drowning.

(a) Whenever an employee may be pulled or pushed, or might fall, into water where the danger of drowning exists, the employer must provide the employee with, and must ensure that the employee uses, a U.S. Coast Guard approved personal flotation device.

(b) The employer must maintain each personal flotation device in safe condition and must inspect each personal flotation device frequently enough to ensure that it does not have rot, mildew, water saturation, or any other condition that could render the device unsuitable for use.

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

(6) Employee protection in public work areas.

(a) Traffic-control signs and traffic-control devices used for the protection of employees must meet 437-003-0424 Traffic Control, of Division 3.

(b) Before employees begin work in the vicinity of vehicular or pedestrian traffic that may endanger them, the employer must place warning signs or flags and other traffic-control devices in conspicuous locations to alert and channel approaching traffic.

(c) The employer must use barricades where additional employee protection is necessary.

(d) The employer must protect excavated areas with barricades.

(e) The employer must display warning lights prominently at night.

(7) Backfeed. When 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 437-002-2311 Working On or Near Exposed Energized Parts, of Division 2/RR, apply if employees will work the lines or equipment as energized; and the requirements of 437-002-2312 Deenergizing Lines and Equipment for Employee Protection, and 437-002-2313 Grounding for the Protection of Employees, of Division 2/RR, apply if employees will work the lines or equipment as deenergized.

(8) Lasers. The employer must install, adjust, and operate laser equipment in accordance with 1926.54 Nonionizing Radiation, of Division 3.

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

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2323 Helicopters

(1) Definitions

(a) Designated employees. Those employees selected or designated by the employer to work under or near helicopters who have first been instructed in hooking, unhooking, guiding and securing the load, including the signal person, all of whom have been instructed in the hazards of helicopter work and who know the provisions of this section.

(b) Pilot in Command or Pilot means the person who:

(A) Has the final authority and responsibility for the operation and safety of the flight;

(B) Has been designated as pilot in command before or during the flight; and

(C) Holds the appropriate category, class, and type rating for the conduct of the flight if applicable.

(c) Helicopter Service Operator. Entity that holds the appropriate Federal Aviation Administration (FAA) operating certification and provides helicopter support services.

(d) Downwash. A down and outward air column from the main rotor system.

(e) Ground personnel or crew. Employees who work on or near the equipment and are familiar with the hazards of helicopter use in power distribution and transmission line work and who know these rules and the methods of operation.

(f) Helicopter, helicopter crane, and rotorcraft. A heavier-than-air aircraft that depends principally for its support in flight on the lift generated by one or more rotors. The use of the word helicopter in these rules also means helicopter crane, rotorcraft, or similar aircraft.

(g) Hooking and unhooking. The process by which an external load is either attached to or detached from the helicopter hook or sling line.

(h) Positive guide system. A system or method of installing a load into position so that the load is capable of being released from the helicopter without being otherwise secured, and the load will remain in position permanently or until otherwise secured by physical means.

(i) Rotors. A system of blades that rotates or revolves to supply lift or direction to the rotorcraft.

(j) Signal person. A member of the ground crew that is designated by an employer to direct, signal and otherwise communicate with the pilot of the helicopter.

(k) Sling. A strap, chain, rope or similar implement used to securely hold something being lifted, lowered, carried or otherwise suspended.

(l) Static charge. An imbalance of electric potential within or on the surface of a material.

(m) Tagline. A rope or similar device used to guide or control the direction or movement of a load.

(2) Helicopter regulations. Helicopter cranes must comply with any applicable regulations of the Federal Aviation Administration (FAA).

(3) Hazard Analysis and Job Briefing.

(a) Before the commencement of any construction, maintenance, or lifting activity using a helicopter, a Job Hazard Analysis (JHA) must be conducted, which, at a minimum, must:

(A) Define the core tasks.

(B) Identify specific hazards.

(C) Identify mission specific tasks.

(D) Describe procedures or controls used to safely manage or mitigate the hazards.

(E) Describe the communication procedure to be used with the crew.

(F) Discuss fatigue, and methods to eliminate or mitigate it.

(G) Specify Minimum Approach Distances (MAD).

(H) Describe a site specific emergency action plan.

(b) A site specific job briefing must be held each day construction, maintenance, or lifting activities using a helicopter are performed.

The daily job briefing at a minimum must:

(A) Summarize or recap the content of the JHA as applicable to the day's duties.

(B) Communicate any site specific hazards not identified in the JHA and provide mitigation for those hazards.

(C) Identify or establish roles for each person who will be interfacing with the aircraft or its loads.

(D) Describe the communication procedure to be used with the crew.

(E) Specify Minimum Approach Distances (MAD) from energized electrical lines and equipment in the work area.

(F) Describe the applicable sections of the site specific emergency action plan, such as the locations of first aid equipment and rescue gear.

(c) An additional job briefing must be held immediately if working conditions change during the course of a job. Working conditions would include weather, wind, and visibility. During the job briefing all affected employees and others, including signal persons, ground workers, pilots, must be advised of the hazards including a change of operation if needed.

(4) Sling and rigging.

(a) The pilot is responsible for the integrity of the rigging for any external load and must ensure safe delivery of the cargo by inspecting and monitoring the security of the rigging throughout the operation. Prior to operations, the pilot must check the condition and application of all rigging gear to ensure serviceability. Prior to commencing operations, determine the complete rigging requirements including slings and taglines.

(b) All personnel involved with rigging activities must receive appropriate rigging training and show proficiency, specific to helicopter operations and the work or task/s being performed.

(c) The slings used for the external load must be inspected each day before use. Slings must be inspected by an employee designated, trained and qualified as a rigger.

(d) No sling can be used unless it has a properly marked minimum tensile strength of five times the load which will be carried or is being carried.

(A) No sling can be used unless upon inspection it is determined to be in good condition and capable of the work which is to be performed, and is properly marked.

(B) Loads must be properly slung so that there will be no slippage or shifting of the load and so that the load will not accidentally be dislodged from the helicopter.

(C) Slings must be the appropriate weight, strength and length to prevent the sling from being lifted and entangled into the aircraft rotor system.

(D) Pressed sleeves, wedged eyes, or equivalent means must be used for all suspended loads using wire rope.

(5) Personal protective equipment when working on, under or in the near vicinity of helicopters:

(a) Personal protective equipment for employees must consist of complete eye protection and hard hats secured by chinstraps.

(b) Loose-fitting clothing likely to flap in the downwash must not be worn.

(6) Loose gear and objects. Every practical precaution must be taken to provide for the protection of the employees from flying objects in the rotor downwash. All loose gear within 100 feet of the place of lifting the load, depositing the load, and all other areas susceptible to rotor downwash must be secured or removed.

(7) Landing Zones.

(a) When establishing the landing zone, the following items must be considered: size and type of helicopter, suitability of the planned activity, physical barriers or obstructions, helicopter touchdown area and congestion in the area.

(b) All helicopter landing, loading and unloading areas must be maintained to reduce the likelihood of flying materials, tripping, or other hazards attendant to the work being performed.

(8) Pilot’s responsibility.

(a) The helicopter pilot is responsible for the size, weight and manner in which loads are connected to the helicopter.

(b) No load can be made if the helicopter pilot believes the lift cannot safely be performed. The employer must make certain that the pilot of the helicopter is able to freely exercise their prerogative and judgment as to safe operation of the helicopter itself concerning size, weight and manner by which loads are connected.

(c) The pilot must possess the appropriate ratings for the aircraft and must be competent to safely conduct the assigned tasks. The pilot has the final authority and is solely responsible for the safe operation of the helicopter loads at all times.

(9) Hooking and unhooking loads.

(a) Work performed at an elevated position and directly under hovering helicopters may be performed only by qualified employees.

(A) Work must be limited to the minimum time necessary to guide, secure, hook or unhook the loads.

(B) When an employee is working from the ground under hovering helicopters, the employee must have a safe means of ingress and egress at all times, including readily available escape route or routes in the event of an emergency.

(b) Positive guide systems must be used for the placement of large segments of a primary tower structure and must enable the heavy lift helicopter to temporarily secure and release the load.

(10) Static charge. All loads must be grounded or bonded with a device capable of discharging either the actual or potential static charge before ground personnel either touch or come close enough to touch the suspended load.

(11) Line Stringing.

(a) Weight of the external load must not exceed the manufacturer’s load limit.

(b) Each helicopter operator engaged in line stringing must be authorized by the Federal Aviation Administration (FAA) for Part 133 Class C operations.

(c) All line stringing operations must be conducted according to the following requirements:

(A) Stringing tension method must enable a consistent positive control of the cable, rope, or similar lines at all times during pulling operations.

(B) During all pulling operations, the helicopter pilot must maintain an aircraft orientation that allows the pilot to maintain constant visibility in both directions on line.

(C) When pulling from the aircraft belly hook attachment point, a ballast weight of a minimum of 300 pounds must be used. At no time during the pulling operation can the load line that is attached to the helicopter's belly hook attachment point exceed a 30 degree angle from vertical. This does not apply when pulling from the helicopter's approved side pull attachment point.

(12) Visibility. Employees must keep clear of and outside the downwash of the helicopter except as necessary to perform a permitted activity.

(13) Communication.

(a) Communication must be maintained between the air crew and ground personnel at all times by a designated and qualified signal person. There must be a constant, open line of communication, using radios or head and hand signals.

(b) Signal systems must be understood by the air crew and the ground crew, including signal persons, prior to the hoisting of any load.

(c) Signaling and maintaining communications with the pilot are the sole and exclusive function of the signal person during periods of loading and unloading. The signal person must be distinguishable from other members of the ground crew by the pilot of the aircraft. This may be by way of orange-colored gloves, vest, or other apparel.

(d) The lead worker and one top person must also have an operating transmitter and receiver.

(e) Authorized and qualified employees may come within 50 feet of the helicopter when the rotor blades are turning, but no closer, other than to enter the craft or to hook or unhook the load or do other essential functions. Other employees may not come closer than 100 feet of the aircraft when it is operating.

(f) The signals between the signal person and the operator of the helicopter must be those submitted to the Federal Aviation Administration for the particular procedure or job. In the event no signals have been submitted to the Federal Aviation Administration, a system of signaling must be used that has been documented and that is capable of being clearly understood by all employees and others involved in the job. When head signals are to be used, the qualified worker must use a visually enhanced hard hat or helmet with clear markings to indicate the desired movement. Any signals other than up/down or in/out will require the use of hand signals.

(g) Should a change occur in the hazards, method of performing the job, signals to be used, or other operating conditions during the course of any particular job, a conference must immediately be held at which time all affected employees and others, including signal persons, ground personnel, and pilots, will be advised of such hazards or change of operation. No employee is permitted to work unless such employee and others fully understand the changes that have taken place.

(14) Helicopter Operation.

(a) Whenever approaching or leaving a helicopter with blades rotating, all employees must remain in full view of the pilot and remain in a crouched position while within 50 feet of the helicopter. No employee can approach the rear of the helicopter unless directly authorized and directed by the pilot of such craft. All employees when operating or working within 50 feet of the helicopter with blades turning are subject to the direction of the helicopter pilot.

(b) All materials and equipment loaded in the aircraft must be properly secured for flight.

(c) Long objects, such as shovels and live-line tools, must be carried horizontally and below the waist to avoid contact with the aircraft rotor blades.

(d) The pilot must ensure that all loads are safely secured to the helicopter, or in cargo baskets, and properly loaded with regard to weight and balance.

(e) Never throw anything while loading and unloading the helicopter. Thrown items may come in contact with the aircraft rotor blade, causing damage to the aircraft and possible injury to ground personnel.

(f) While in the helicopter, safety belts must remain fastened at all times except when pilot instructs otherwise or while entering or leaving the helicopter.

(g) Smoking in the helicopter is prohibited at all times.

(15) Helicopter Work Tasks.

(a) Human External Cargo (HEC)

(A) The sling or vertical suspension system for HEC is a vertical system suspended from the helicopter cargo hook. The sling system must comply with FAA regulation 14 CFR Part 133 Class B or D – External Load.

(B) Helicopter operations involving HEC must incorporate the use of a secondary safety device, in addition to the helicopter's primary attachment means, to prevent the inadvertent release of the load. This device must remain able to be jettisoned in accordance with class B load requirements.

(i) HEC lines must be not less than 10:1 safety ratio between the rated breaking strength and the working load.

(ii) All harnesses used for helicopter short-haul operations must meet the ANSI Z359.1-2007 standards for class III (full body) harnesses and must be equipped with both dorsal and sternal D rings.

(iii) All suspension harnesses used for HEC must be adjusted to the user, and the harness must be equipped with an orthostatic shock relief device. Such devices must be used on flights lasting over five minutes.

(b) Hover Transfer.

(A) The qualified line worker must be attached to the helicopter at all times when traveling between the ground and the aerial transfer point or worksite. There must be an FAA approved attachment point on the helicopter for the lineman's safety harness lanyard.

(B) If a platform system is used to transport crews, or if a crewmember performs work from a platform system, the platform system and all aircraft attachment points must comply with applicable FAA regulations and requirements.

(C) All platform operations must be conducted in accordance with the 14 CFR Part 133 Class A - External Load.

(D) Flight and hovering capabilities of the helicopter must not be adversely affected by the design of the platform.

(E) The platform may not adversely affect the auto rotation and emergency capabilities of the helicopter.

(F) The platform and loads may affect the lateral & longitudinal center of gravity weight and balance of the helicopter in flight, therefore an engineered counter-balance system which will ensure stability must be used if the platform exceeds the lateral center of gravity limits of the manufactures specifications for the helicopter.

(16) Fires. Open fires are not permitted in any area where fires will be affected by the downwash of the rotors, nor can any employee smoke in an area subject to the downdraft of the rotor.

(17) Refueling operations.

(a) Refueling any helicopter with either aviation gasoline or Jet B (Turbine) type fuel is prohibited while the engines are running.

(b) Fueling of helicopters using Jet A (Turbine-Kerosene) type fuel is allowed with engines running.

(c) All helicopter fueling must comply with the following:

(A) No unauthorized people are allowed within fifty feet of the refueling operation or fueling equipment.

(B) Fire extinguishers must be available and must be in compliance with FAA regulations.

(C) All fueling personnel must be thoroughly trained in the refueling operation and in the use of the available fire extinguishing equipment they may be expected to use.

(D) There must be no smoking, open flames, exposed flame heaters, flare pots, or open flame lights within fifty feet of the refueling area or fueling equipment. The refueling area or the fuel truck must be posted with “no smoking” signs.

(E) Prior to making any fueling connection to the aircraft, the fueling equipment must be bonded to the aircraft by use of a cable, thus providing a conductive path to equalize the potential between the fueling equipment and the aircraft. The bond must be maintained until fueling connections have been removed, thus allowing separated charges that could be generated during the fueling operation to reunite. Grounding during aircraft fueling is not permitted

(F) To control spills, fuel must be pumped either by hand or power. Pouring or gravity flow is not permitted. Self-closing nozzles or deadman controls must be used and may not be blocked open. Nozzles may not be dragged along the ground.

(G) In case of a spill, the fueling operation must be immediately stopped until such time as the person in charge determines that it is safe to resume the refueling operation.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

437-002-2324 Definitions.

(1) 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.

(2) 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.

(3) 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 Division 2/RR.

(4) Automatic circuit recloser. 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.

(5) Barricade. A physical obstruction such as tapes, cones, or A-frame type wood or metal structures that provides a warning about, and limits access to, a hazardous area.

(6) Barrier. A physical obstruction that prevents contact with energized lines or equipment or prevents unauthorized access to a work area.

(7) Bond. The electrical interconnection of conductive parts designed to maintain a common electric potential.

(8) Bus. A conductor or a group of conductors that serve as a common connection for two or more circuits.

(9) Bushing. An insulating structure that includes a through conductor or that provides a passageway for such a conductor, and that, when mounted on a barrier, insulates the conductor from the barrier for the purpose of conducting current from one side of the barrier to the other.

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

(11) Cable sheath. A conductive protective covering applied to cables.

Note to the definition of "cable sheath": A cable sheath may consist of multiple layers one or more of which is conductive.

(12) Circuit. A conductor or system of conductors through which an electric current is intended to flow.

(13) Clearance (between objects). The clear distance between two objects measured surface to surface.

(14) Clearance (for work). Authorization to perform specified work or permission to enter a restricted area.

(15) Clearance (electrical). Notification from an authorized person that all necessary actions have been taken to de-energize a circuit, line, or equipment and the line or equipment is safe to be worked, so that workers may be authorized to proceed with intended operations.

(16) Communication lines. (See Lines; (a) Communication lines.)

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

(18) Contract employer. An employer, other than a host employer, that performs work covered by this section under contract.

(19) 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.

(20) 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.

(21) Deenergized. Free from any electrical connection to a source of potential difference and from electric charge; not having a potential that is different from the potential of the earth.

Note to the definition of "deenergized": The term applies only to current-carrying parts, which are sometimes energized (alive).

(22) Designated employee (designated person). An employee (or person) who is assigned by the employer to perform specific duties under the terms of this section and who has sufficient knowledge of the construction and operation of the equipment, and the hazards involved, to perform his or her duties safely.

(23) Drop start (Chain saws): The process of starting a chain saw by simultaneously pushing it away from the body with one hand and pulling the starter cord handle with the other.

(24) Electric line truck. A truck used to transport personnel, tools, and material for electric supply line work.

(25) Electric supply equipment. Equipment that produces, modifies, regulates, controls, or safeguards a supply of electric energy.

(26) Electric supply lines. (See Lines; (b) Electric supply lines.)

(27) Electric utility. An organization responsible for the installation, operation, or maintenance of an electric supply system.

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

Note to the definition of "enclosed space": Oregon OSHA does not consider spaces that are enclosed but not designed for employee entry under normal operating conditions to be enclosed spaces for the purposes of this section. Similarly, Oregon OSHA does not consider spaces that are enclosed and that are expected to contain a hazardous atmosphere to be enclosed spaces for the purposes of this Subdivision. Such spaces meet the definition of permit spaces in 1910.146, and entry into them must conform to that standard.

(29) 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.

(30) 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.)

(31) Energy source. Any electrical, mechanical, hydraulic, pneumatic, chemical, nuclear, thermal, or other energy source that could cause injury to employees.

(32) Entry (as used in 437-002-2304 Enclosed spaces, of Division 2/RR). The action by which a person passes through an opening into an enclosed space. Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

(33) 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.

(34) Exposed, Exposed to contact (as applied to energized parts). Not isolated or guarded.

(35) Fall restraint system. A fall protection system that prevents the user from falling any distance.

(36) First-aid training. Training in the initial care, including cardiopulmonary resuscitation (which includes chest compressions, rescue breathing, and, as appropriate, other heart and lung resuscitation techniques), performed by a person who is not a medical practitioner, of a sick or injured person until definitive medical treatment can be administered.

(37) Ground. A conducting connection, whether planned or unplanned, between an electric circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

(38) Grounded. Connected to earth or to some conducting body that serves in place of the earth.

(39) 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 inadvertent contact by persons or objects.

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

(40) Hazardous atmosphere. 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:

(a) Flammable gas, vapor, or mist in excess of 10 percent of its lower flammable limit (LFL);

(b) Airborne combustible dust at a concentration that meets or exceeds its LFL;

Note to the definition of "hazardous atmosphere" (2): This concentration may be approximated as a condition in which the dust obscures vision at a distance of 1.52 meters (5 feet) or less.

(c) Atmospheric oxygen concentration below 19.5 percent or above 23.5 percent;

(d) Atmospheric concentration of any substance for which a dose or a permissible exposure limit is in Division 2/G, Occupational Health and Environmental Control; Division 3/D, Occupational Health and Environmental Controls; or in subdivisions Z, Toxic and Hazardous Substances, of Division 2 and Division 3; and which could result in employee exposure in excess of its dose or permissible exposure limit;

Note to the definition of "hazardous atmosphere" (4): 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.

(e) Any other atmospheric condition that is immediately dangerous to life or health.
Note to the definition of "hazardous atmosphere" (5): For air contaminants for which Oregon OSHA has not determined a dose or permissible exposure limit, other sources of information, such as Safety Data Sheets that comply with the Hazard Communication Standard, 1910.1200 of Division 2, and 1926.1200 of Division 3, published information, and internal documents can provide guidance in establishing acceptable atmospheric conditions.

(41) High-power tests. Tests in which the employer uses fault currents, load currents, magnetizing currents, and line-dropping currents to test equipment, either at the equipment's rated voltage or at lower voltages.

(42) High-voltage tests. Tests in which the employer uses voltages of approximately 1,000 volts as a practical minimum and in which the voltage source has sufficient energy to cause injury.

(43) High wind. A wind of such velocity that one or more of the following hazards would be present:

(a) The wind could blow an employee from an elevated location,

(b) The wind could cause an employee or equipment handling material to lose control of the material, or

(c) The wind would expose an employee to other hazards not controlled by the standard involved.

Note to the definition of "high wind": Oregon OSHA normally considers winds exceeding 64.4 kilometers per hour (40 miles per hour), or 48.3 kilometers per hour (30 miles per hour) if the work involves material handling, as meeting this criteria, unless the employer takes precautions to protect employees from the hazardous effects of the wind.

(44) Host employer. An employer that operates, or that controls the operating procedures for, an electric power generation, transmission, or distribution installation on which a contract employer is performing work covered by this section.

Note to the definition of "host employer": Oregon OSHA will treat the electric utility or the owner of the installation as the host employer if it operates or controls operating procedures for the installation. If the electric utility or installation owner neither operates nor controls operating procedures for the installation, Oregon OSHA will treat the employer that the utility or owner has contracted with to operate or control the operating procedures for the installation as the host employer. In no case will there be more than one host employer.

(45) Immediately dangerous to life or health (IDLH). 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 to the definition of "immediately dangerous to life or health": 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.

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

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

(47) Insulation (cable). Material relied upon to insulate the conductor from other conductors or conducting parts or from ground.

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

(49) 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 to the definition of "line-clearance tree trimmer": 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 to the definition of "line-clearance tree trimmer": A line-clearance tree trimmer is not considered to be a "qualified employee" under Subdivision RR unless he or she has the training required for a qualified employee under 437-002-2300(2)(b), General: Training, of Subdivision RR. However, under the electrical safety-related work practices standard in Division 2/S, 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 Division 2/S when it is directly associated with electric power generation, transmission, or distribution lines or equipment. (See 1910.331 for requirements on the applicability of the electrical safety-related work practice requirements contained in 1910.331 through 1910.335 to line-clearance tree trimming performed by such “qualified employees,” and see the note following 1910.332(b)(3) of Division 2/S for information regarding the training an employee must have to be considered a qualified employee under 1910.331 through 1910.335 of Division 2/S.)

(50) Line-clearance tree trimming. The pruning, trimming, repairing, maintaining, removing, or clearing of trees, or the cutting of brush, that is within the following distance of electric supply lines and equipment:

(a) For voltages to ground of 50 kilovolts or less-3.05 meters (10 feet);

(b) For voltages to ground of more than 50 kilovolts-3.05 meters (10 feet) plus 0.10 meters (4 inches) for every 10 kilovolts over 50 kilovolts.

Note to the definition of “line-clearance tree trimming”: This section applies only to line-clearance tree trimming performed for the purpose of clearing space around electric power generation, transmission, or distribution lines or equipment and on behalf of an organization that operates, or that controls the operating procedures for, those lines or equipment. See paragraph (1) of 437-002-2300. Tree trimming performed on behalf of a homeowner or commercial entity other than an organization that operates, or that controls the operating procedures for, electric power generation, transmission, or distribution lines or equipment is not directly associated with an electric power generation, transmission, or distribution installation and is outside the scope of this section. In addition, tree trimming that is not for the purpose of clearing space around electric power generation, transmission, or distribution lines or equipment is not directly associated with an electric power generation, transmission, or distribution installation and is outside the scope of this section. Such tree trimming may be covered by other applicable standards. See, for example, 437-002-0268 and 1910.331 through 1910.335 of Division 2.

(51) Lines.

(a) 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 to the definition of "communication lines": 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.

(b) 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.

(52) Manhole. A subsurface enclosure that personnel may enter and that is used for installing, operating, and maintaining submersible equipment or cable.

(53) Minimum approach distance. The closest distance an employee may approach an energized or a grounded object.

Note to the definition of "minimum approach distance": 437-002-2311 (3)(a), Working on or near exposed energized parts, requires employers to establish minimum approach distances.

(54) Personal fall arrest system. A system used to arrest an employee in a fall from a working level.

(55) Power-line Carrier (PLC). An electric power transmission and distribution conductor that simultaneously carries data, such as internet broadband. Also known as power-line networking (PLN) or power-line communication.

(56) Qualified employee (qualified person). An employee (person) knowledgeable in the construction and operation of the electric power generation, transmission, and distribution equipment involved, along with the associated hazards.

Note 1 to the definition of "qualified employee (qualified person)": An employee must have the training required by 437-002-2300(2)(b) General, Training; to be a qualified employee.

Note 2 to the definition of "qualified employee (qualified person)": an employee who is undergoing on-the-job training and who has demonstrated, in the course of such training, 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 a qualified person for the performance of those duties.

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

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

(59) Switch. A device for opening and closing or for changing the connection of a circuit. In this section, a switch is manually operable, unless otherwise stated.

(60) System operator. A qualified person who has been designated by the employer to have authority over switching, clearances, and operation of the system and its parts.

(61) Vault. An enclosure, above or below ground, that personnel may enter and that is used for installing, operating, or maintaining equipment or cable.

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

(63) Voltage. The effective (root mean square, or rms) potential difference between any two conductors or between a conductor and ground. This section expresses voltages 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.

(64) Voltage (low). Voltage of 600 volts or less.

(65) Voltage (high). Voltage greater than 600 volts.

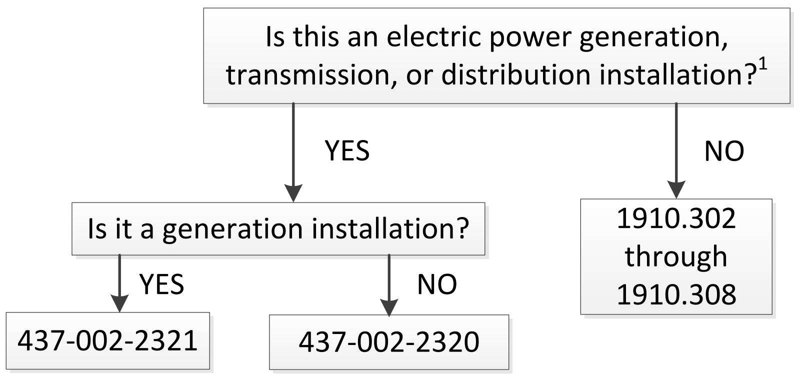
(66) Work-positioning equipment. A body belt or body harness system rigged to allow an employee to be supported on an elevated vertical surface, such as a utility pole or tower leg, and work with both hands free while leaning.

Stat. Auth.: ORS 654.025(2) and 656.726(4)
Stats. Implemented: ORS 654.001 through 654.295.
Hist.: OR-OSHA Admin. Order 3-2015, f. 10/9/15, ef. 1/1/16.

Appendix A to Division 2/RR – Flow Charts

This appendix presents information, in the form of flow charts, that illustrates the scope and application of Division 2/RR. This appendix addresses the interface between Division 2/RR and Division 2/S (Electrical), between Division 2/RR and 437-002-0146 (Confined spaces), and between Division 2/RR and 1910.147 (The control of hazardous energy (lockout/tagout)). These flow charts provide guidance for employers trying to implement the requirements of Division 2/RR in combination with other general industry standards contained in Division 2. Employers should always consult the relevant standards, in conjunction with this appendix, to ensure compliance with all applicable requirements.

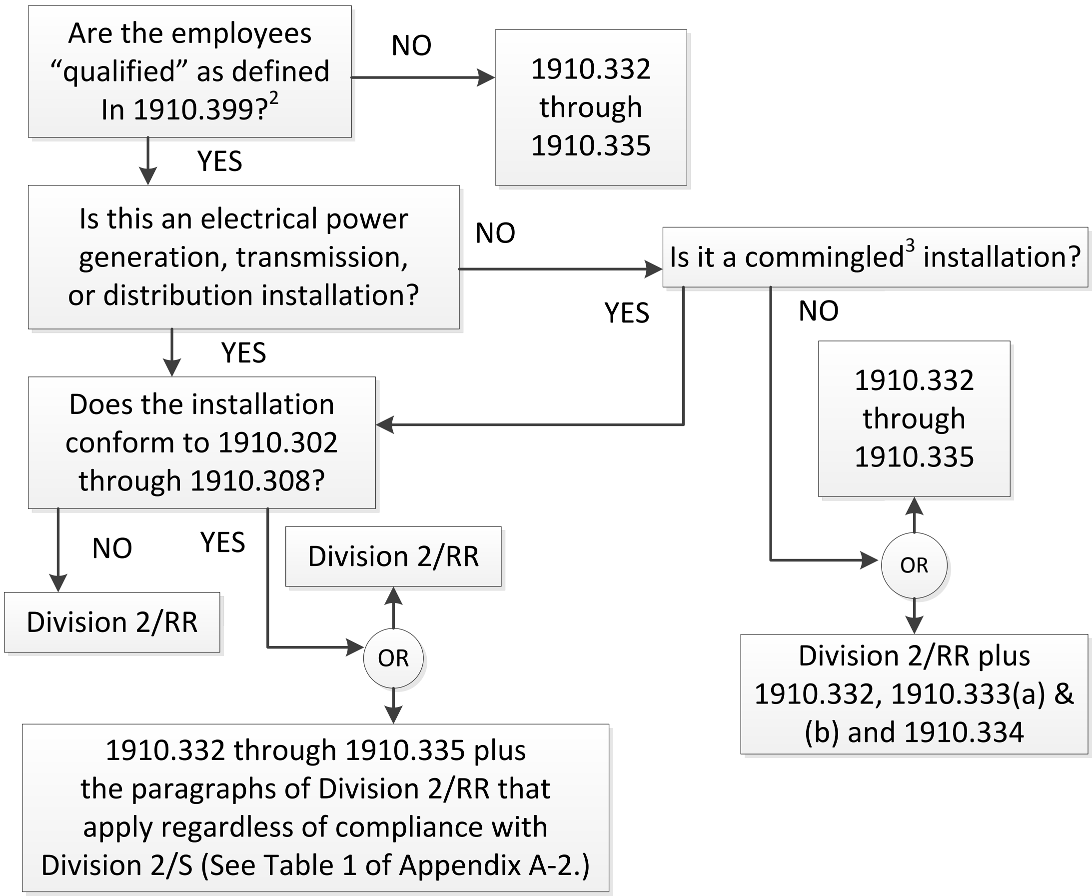
Appendix A-1 to Division 2/RR –
Application of Division 2/RR and Division 2/S to Electrical Installations.



[1] This chart applies to electrical installation design requirements only. See Appendix A-2 for electrical safety-related work practices. Supplementary electric generating equipment that is used to supply a workplace for emergency, standby, or similar purposed only is not considered an electric power generation installation.

Appendix A-2 to Division 2/RR – Application of Division 2/RR and

Division 2/S to Electrical Safety-Related Work Practices[1].



[1] This flowchart applies only to the electrical safety-related work practice and training requirements in Division 2/RR and 1910.332 through 1910.335.

[2] See 437-002-2300(1)(f) and 1910.331(b) and (c)(1)

[3] This means commingled to the extent that the electric power generation, transmission, or distribution installation poses the greater hazard.

Table 1 – Electrical Safety-Related Work Practices in Division 2/RR

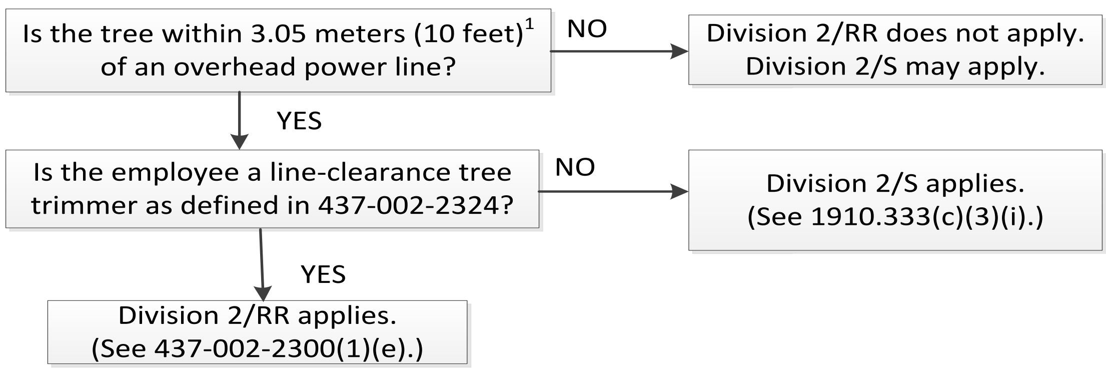
Compliance with Division 2/S will comply with these paragraphs of Division 2/RR[1]	Paragraphs that apply regardless of compliance with Division 2/S[2]
437-002-2303, electric-shock hazards only	437-002-2300(2), (3), and (4)
437-002-2307(3)	437-002-2301
437-002-2308(2) and (3)	437-002-2302
437-002-2310	437-002-2303, for other than electric-shock hazards
437-002-2311(1)-(5), (7), (10)-(12)	437-002-2304
437-002-2312	437-002-2305
437-002-2315(4)	437-002-2306
437-002-2318(2)	437-002-2307(1) and (2)
437-002-2320(1), (3)-(5)	437-002-2308(4)
437-002-2321(3)-(5)	437-002-2309
437-002-2322(1), (7)	437-002-2311(6), (8), and (9)
	437-002-2313
	437-002-2314
	437-002-2315(1)-(3)
	437-002-2316
	437-002-2317
	437-002-2318(1)
	437-002-2319
	437-002-2320(2), (6)
	437-002-2321(1), (2), (6)-(12)
	437-002-2322(2)-(6), (8), (9)

[1] If the electrical installation meets the requirements of 1910.303 through 1910.308, then the electrical installation and any associated electrical safety-related work practices conforming to 1910.332 through 1910.335 of Division 2/S are considered to comply with these provisions of Division 2/RR.

[2] These provisions include electrical safety requirements that must be met regardless of compliance with Division 2/S.

Appendix A-3 to Division 2/RR -- Application of Division 2/RR

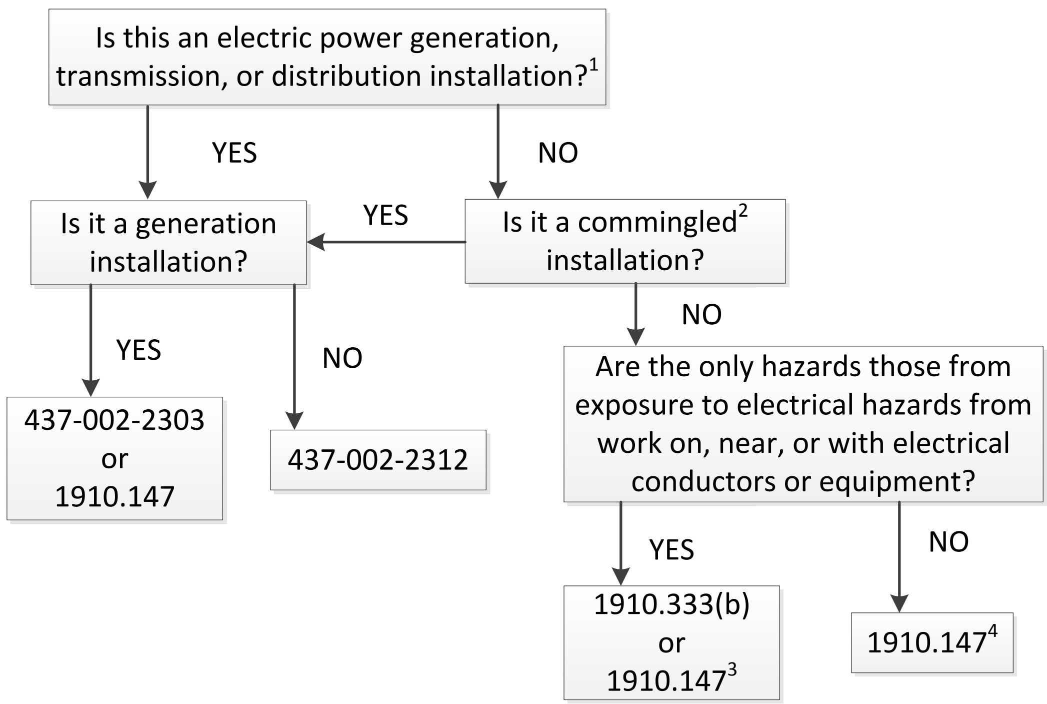
and Division 2/S to Tree-Trimming Operations.



[1] 3.05 meters (10 feet) plus 0.10 meters (4 inches for every 10 kilovolts over 50 kilovolts.

Appendix A-4 to Division 2/RR -- Application of 1910.147, Division 2/RR and

1910.333 to Hazardous Energy Control Procedures (Lockout/Tagout).



[1] If a generation, transmission, or distribution installation conforms to 1910.302 through 1910.308, the lockout and tagging procedures of 1910.333(b) may be followed for electric-shock hazards.

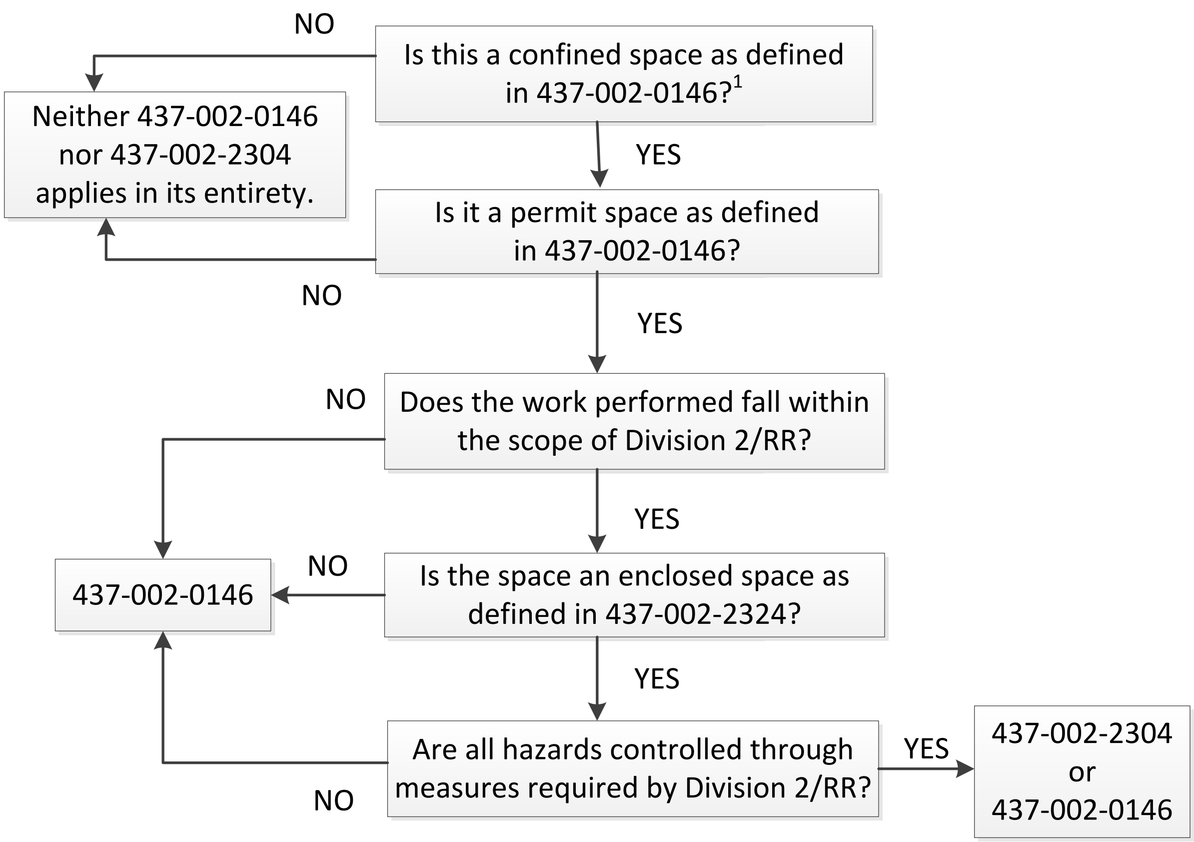
[2] This means commingled to the extent that the electric power generation, transmission, or distribution installation poses the greater hazard.

[3] Paragraphs (b)(2)(iii)(D) and (b)(2)(iv)(B) of 1910.333 still apply.

[4] Paragraph (b) of 1910.333 applies to any electrical hazards from work on, near, or with electric conductors and equipment.

Appendix A-5 to Division 2/RR –

Application of 437-002-0146 and Division 2/RR to Permit-Required Confined Spaces.



[1] See 437-002-0146 for general nonentry requirements that apply to all confined spaces.

Note: 437-002-2319 contains additional requirements for work in manholes and underground vaults.

Appendix B to Division 2/RR – Working on Exposed Energized Parts

I. Introduction

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

The information in this appendix will assist employers in complying with the minimum approach-distance requirements contained in 437-002-2311(3) and 437-002-2316(3). Employers must use the technical criteria and methodology presented in this appendix in establishing minimum approach distances in accordance with 437-002-2311(3)(a) and Table RR-2 and Table RR-7. This appendix provides essential background information and technical criteria for the calculation of the required minimum approach distances for live-line work on electric power generation, transmission, and distribution installations.

Unless an employer is using the maximum transient overvoltages specified in Table RR-8 for voltages over 72.5 kilovolts, the employer must use persons knowledgeable in the techniques discussed in this appendix, and competent in the field of electric transmission and distribution system design, to determine the maximum transient overvoltage.

II. General

A. Definitions. The following definitions from 437-002-2324 relate to work on or near electric power generation, transmission, and distribution lines and equipment and the electrical hazards they present.

Exposed. Not isolated or guarded.

Guarded. Covered, 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 inadvertent contact by persons or objects.

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

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

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

Isolated. Not readily accessible to persons unless special means for access are used.

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

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

B. Installations energized at 50 to 300 volts. The hazards posed by installations energized at 50 to 300 volts are the same as those found in many other workplaces. That is not to say that there is no hazard, but the complexity of electrical protection required does not compare to that required for highvoltage 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. 437-002-2311(3)(a) requires the employer to establish minimum approach distances no less than the distances computed by Table RR-2 for ac systems so that employees can work safely without risk of sparkover.[2]

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

Normal system design may provide or include a means (such as lightning arrestors) to control maximum anticipated transient overvoltages, or the employer may use temporary devices (portable protective gaps) or measures (such as preventing automatic circuit breaker reclosing) to achieve the same result. 437-002-2311(3)(b) requires the employer to determine the maximum anticipated per-unit transient overvoltage, phase-to-ground, through an engineering analysis or assume a maximum anticipated per-unit transient overvoltage, phase-to-ground, in accordance with Table RR-8, which specifies the following maximums for ac systems:

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

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

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

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

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

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

TABLE 1-SPARKOVER DISTANCE FOR ROD-TO-ROD GAP			
60 Hz Rod-to-Rod sparkover (kV peak)	Gap spacing from IEEE Std 4-1995 (cm)	60 Hz Rod-to-Rod sparkover (kV peak)	Gap spacing from IEEE Std 4-1995 (cm)
25	2	112	18
36	3	120	20
46	4	143	25
53	5	167	30
60	6	192	35
70	8	218	40
79	10	243	45
86	12	270	50
95	14	322	60
104	16		
Source: IEEE Std 516-2009.			

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

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

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

TABLE 2-CALCULATING THE ELECTRICAL COMPONENT OF MAD 751 V TO 72.5 KV				
Step	Maximum system phase-to-phase voltage (kV)			
	15	36	46	72.5
1. Divide by √3	8.7	20.8	26.6	41.9
2. Multiply by √2	12.2	29.4	37.6	59.2
3. Multiply by 3.0	36.7	88.2	112.7	177.6
4. Divide by 0.85	43.2	103.7	132.6	208.9
5. Interpolate from Table 1	3+(7.2/10)*1	14+(8.7/9)*2	20+(12.6/23)*5	35+(16.9/26)*5
Electrical component of MAD (cm)	3.72	15.93	22.74	38.25

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

Equation 1 - For Voltages of 72.6 kV to 800 kV

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

Where:
D = Electrical component of the minimum approach distance in air in meters;
C = a correction factor associated with the variation of gap sparkover with voltage;
a = A factor relating to the saturation of air at system voltages of 345 kilovolts or higher; [4]
VL-G = Maximum system line-to-ground rms voltage in kilovolts-it should be the "actual" maximum, or the normal highest voltage for the range (for example, 10 percent above the nominal voltage); and
T = Maximum transient overvoltage factor in per unit.
In Equation 1, C is 0.01: (1) For phase-to-ground exposures that the employer can demonstrate consist only of air across the approach distance (gap) and (2) for phase-to-phase exposures if the employer can demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap. Otherwise, C is 0.011.

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

TABLE 3-EQUATIONS FOR CALCULATING THE SURGE FACTOR, *a*			
Phase-to-ground exposures			
$V_{Peak} = TL\text{-}GVL\text{-}G\sqrt{2}$	635 kV or less 0	635.1 to 915 kV $(V_{Peak}-635)/140{,}000$	915.1 to 1,050 kV $(V_{Peak}-645)/135{,}000$
a			
$V_{Peak} = TL\text{-}GVL\text{-}G\sqrt{2}$	More than 1,050 kV		
a	$(V_{Peak}-675)/125{,}000$		
Phase-to-phase exposures [1]			
$V_{Peak} = (1.35TL\text{-}G + 0.45)VL\text{-}G\sqrt{2}$	630 kV or less 0	630.1 to 848 kV $(V_{Peak}-630)/155{,}000$	848.1 to 1,131 kV $(V_{Peak}-633.6)/152{,}207$
a			
$V_{Peak} = (1.35TL\text{-}G + 0.45)VL\text{-}G\sqrt{2}$	1,131.1 to 1,485 kV $(V_{Peak}-628)/153{,}846$	More than 1,485 kV $(V_{Peak}-350.5)/203{,}666$	
a			
[1] Use the equations for phase-to-ground exposures (with V_{Peak} for phase-to-phase exposures) unless the employer can demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap.			

In Equation 1, T is the maximum transient overvoltage factor in per unit. As noted earlier, 437-002-2311(3)(b) requires the employer to determine the maximum anticipated per-unit transient overvoltage, phase-to-ground, through an engineering analysis or assume a maximum anticipated per-unit transient overvoltage, phase-to-ground, in accordance with Table RR-8. For phase-to-ground exposures, the employer uses this value, called TL-G, as T in Equation 1. IEEE Std 516-2009 provides the following formula to calculate the phase-to-phase maximum transient overvoltage, TL-L, from TL-G:

$$TL\text{-}L = 1.35TL\text{-}G + 0.45$$

For phase-to-phase exposures, the employer uses this value as T in Equation 1.

D. Provisions for inadvertent movement. The minimum approach distance 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. This "adder" must account for this possible inadvertent movement and provide the worker with a comfortable and safe zone in which to work. Employers must add the distance for inadvertent movement (called the "ergonomic component of the minimum approach distance") to the electrical component to determine the total safe minimum approach distances used in live-line work.
The Occupational Safety and Health Administration based the ergonomic component of the minimum approach distance on response time-distance analysis. This technique uses an estimate of the total response time to a hazardous incident and converts that time to the distance traveled. For example, the driver of a car takes a given amount of time to respond to a "stimulus" and stop the vehicle. The elapsed time involved results in the car's traveling some distance before coming to a complete stop. This distance depends on the speed of the car at the time the stimulus appears and the reaction time of the driver.

In the case of live-line work, the employee 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, the employee will travel some distance. This is the distance the employer must add to the electrical component of the minimum approach distance to obtain the total safe minimum approach distance.

At voltages from 751 volts to 72.5 kilovolts,[5] the electrical component of the minimum approach distance is smaller than the ergonomic component. At 72.5 kilovolts, the electrical component is only a little more than 0.3 meters (1 foot). An ergonomic component of the minimum approach distance must provide for all the worker's unanticipated movements. At these voltages, workers generally use rubber insulating gloves; however, these gloves protect only a worker's hands and arms. Therefore, the energized object must be at a safe approach distance to protect the worker's face. In this case, 0.61 meters (2 feet) is a sufficient and practical ergonomic component of the minimum approach distance.

For voltages between 72.6 and 800 kilovolts, employees must use different work practices during energized line work. Generally, employees use live-line tools (hot sticks) to perform work on energized equipment. These tools, by design, keep the energized part at a constant distance from the employee and, thus, maintain the appropriate minimum approach distance automatically.

The location of the worker and the type of work methods the worker is using also influence the length of the ergonomic component of the minimum approach distance. In this higher voltage range, the employees use work methods that more tightly control their movements than when the workers perform work using rubber insulating gloves. The worker, therefore, is farther from the energized line or equipment and must be more precise in his or her movements just to perform the work. For these reasons, this section adopts an ergonomic component of the minimum approach distance of 0.31 m (1 foot) for voltages between 72.6 and 800 kilovolts.

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

TABLE 4 - ERGONOMIC COMPONENT OF MINIMUM APPROACH DISTANCE		
Voltage range (kV)	Distance	
	m	ft
0.301 to 0.750	0.31	1.0
0.751 to 72.5	0.61	2.0
72.6 to 800	0.31	1.0

Note: The employer must add this distance to the electrical component of the minimum approach distance to obtain the full minimum approach distance.

The ergonomic component of the minimum approach distance accounts for errors in maintaining the minimum approach distance (which might occur, for example, if an employee misjudges the length of a conductive object he or she is holding), and for errors in judging the minimum approach distance. The ergonomic component also accounts for inadvertent movements by the employee, such as slipping. In contrast, the working position selected to properly maintain the minimum approach distance must account for all of an employee's reasonably likely movements and still permit the employee to adhere to the applicable minimum approach distance. (See Figure 1.) Reasonably likely movements include an employee's adjustments to tools, equipment, and working positions and all movements needed to perform the work. For example, the employee should be able to perform all of the following actions without straying into the minimum approach distance:

Adjust his or her hardhat, maneuver a tool onto an energized part with a reasonable amount of overreaching or underreaching, reach for and handle tools, material, and equipment passed to him or her, and adjust tools, and replace components on them, when necessary during the work procedure.

The training of qualified employees required under 437-002-2300(2), and the job planning and briefing required under 437-002-2302, must address selection of a proper working position.

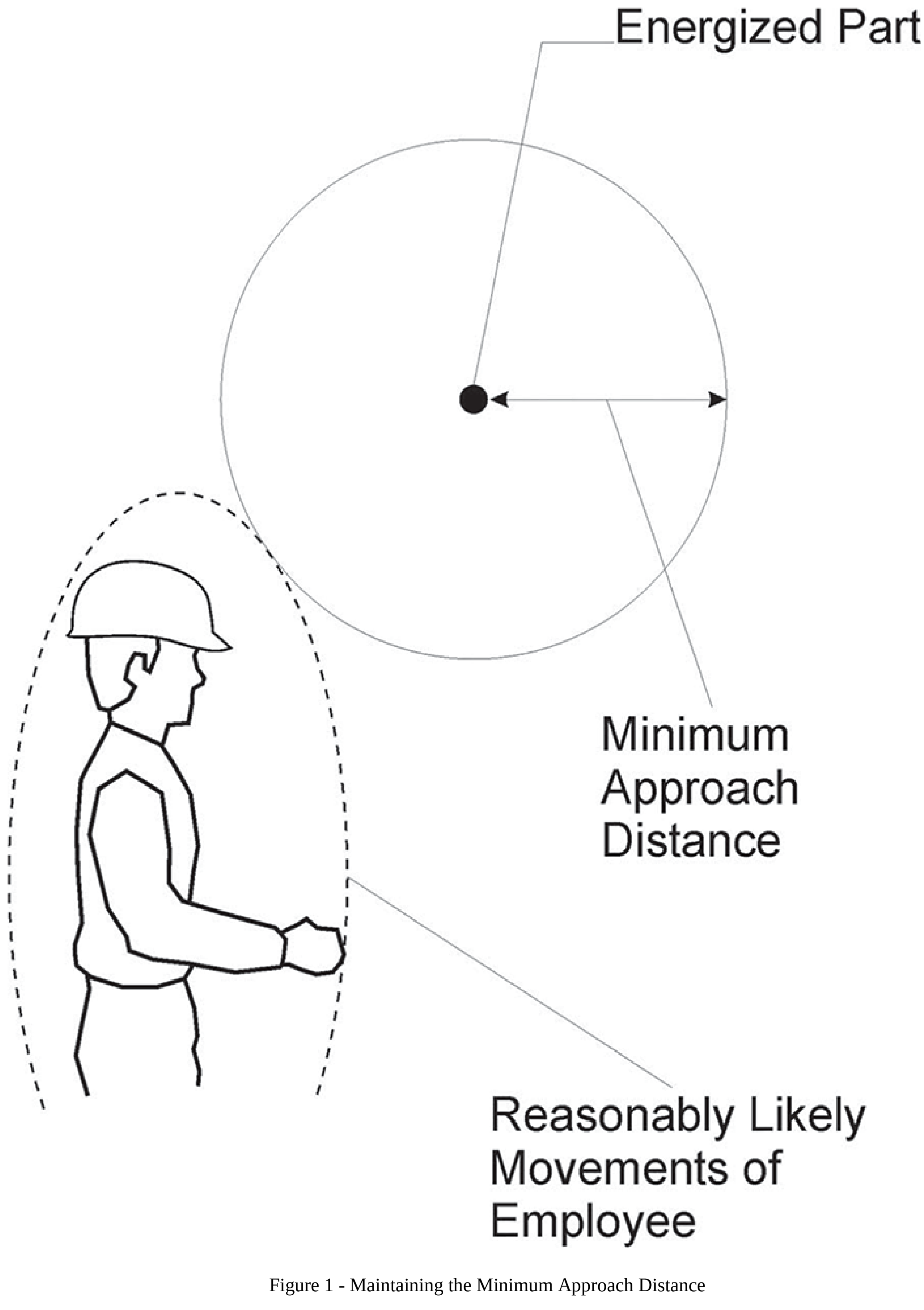


Figure 1 - Maintaining the Minimum Approach Distance

E. Miscellaneous correction factors. Changes in the air medium that forms the insulation influences the strength of an air gap. A brief discussion of each factor follows.

1. Dielectric strength of air. The dielectric strength of air in a uniform electric field at standard atmospheric conditions is approximately 3 kilovolts per millimeter.[6]
The pressure, temperature, and humidity of the air, the shape, dimensions, and separation of the electrodes, and the characteristics of the applied voltage (wave shape) affect the disruptive gradient.

2. Atmospheric effect. The empirically determined electrical strength of a given gap is normally applicable at standard atmospheric conditions (20 °C, 101.3 kilopascals, 11 grams/cubic centimeter humidity). An increase in the density (humidity) of the air inhibits sparkover for a given air gap. The combination of temperature and air pressure that results in the lowest gap sparkover voltage is high temperature and low pressure. This combination of conditions is not likely to occur. Low air pressure, generally associated with high humidity, causes increased electrical strength. An average air pressure generally correlates with low humidity. Hot and dry working conditions normally result in reduced electrical strength. The equations for minimum approach distances in Table RR-2 assume standard atmospheric conditions.

3. Altitude. The reduced air pressure at high altitudes causes a reduction in the electrical strength of an air gap. An employer must increase the minimum approach distance by about 3 percent per 300 meters (1,000 feet) of increased altitude for altitudes above 900 meters (3,000 feet). Table RR-4 specifies the altitude correction factor that the employer must use in calculating minimum approach distances.

IV. Determining Minimum Approach Distances

A. Factors Affecting Voltage Stress at the Worksite

1. System voltage (nominal). The nominal system voltage range determines the voltage for purposes of calculating minimum approach distances. The employer selects the range in which the nominal system voltage falls, as given in the relevant table, and uses the highest value within that range in perunit calculations.

2. Transient overvoltages. Operation of switches or circuit breakers, a fault on a line or circuit or on an adjacent circuit, and similar activities may generate transient overvoltages on an electrical system. Each overvoltage has an associated transient voltage wave shape. The wave shape arriving at the site and its magnitude vary considerably.
In developing requirements for minimum approach distances, the Occupational Safety and Health Administration considered the most common wave shapes and the magnitude of transient overvoltages found on electric power generation, transmission, and distribution systems. The equations in Table RR-2 for minimum approach distances use per-unit maximum transient overvoltages, which are relative to the nominal maximum voltage of the system. For example, a maximum transient overvoltage value of 3.0 per unit indicates that the highest transient overvoltage is 3.0 times the nominal maximum system voltage.

3. Typical magnitude of overvoltages. Table 5 lists the magnitude of typical transient overvoltages.

TABLE 5 - MAGNITUDE OF TYPICAL TRANSIENT OVERVOLTAGES	
Cause	Magnitude (per unit)
Energized 200-mile line without closing resistors	3.5
Energized 200-mile line with one-step closing resistor	2.1
Energized 200-mile line with multistep resistor	2.5
Reclosing with trapped charge one-step 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 to 1.9

4. Standard deviation-air-gap withstand. For each air gap length under the same atmospheric conditions, there is a statistical variation in the breakdown voltage. The probability of breakdown against voltage has a normal (Gaussian) distribution. The standard deviation of this distribution varies with the wave shape, gap geometry, and atmospheric conditions. The withstand voltage of the air gap is three standard deviations (3s) below the critical sparkover voltage. (The critical sparkover voltage is the crest value of the impulse wave that, under specified conditions, causes sparkover 50 percent of the time. An impulse wave of three standard deviations below this value, that is, the withstand voltage, has a probability of sparkover of approximately 1 in 1,000.)
5. Broken Insulators. Tests show reductions in the insulation strength of insulator strings with broken skirts. Broken units may lose up to 70 percent of their withstand capacity. Because an employer cannot determine the insulating capability of a broken unit without testing it, the employer must consider damaged units in an insulator to have no insulating value. Additionally, the presence of a live-line tool alongside an insulator string with broken units may further reduce the overall insulating strength. The number of good units that must be present in a string for it to be "insulated" as defined by 437-002-2324 depends on the maximum overvoltage possible at the worksite.

B. Minimum Approach Distances Based on Known, Maximum-Anticipated Per-Unit Transient Overvoltages
1. Determining the minimum approach distance for AC systems. Under 437-002-2311(3)(b), the employer must determine the maximum anticipated per-unit transient overvoltage, phase-to-ground, through an engineering analysis or must assume a maximum anticipated per-unit transient overvoltage, phase-to-ground, in accordance with Table RR-8. When the employer conducts an engineering analysis of the system and determines that the maximum transient overvoltage is lower than specified by Table RR-8, the employer must ensure that any conditions assumed in the analysis, for example, that employees block reclosing on a circuit or install portable protective gaps, are present during energized work. To ensure that these conditions are present, the employer may need to institute new livework procedures reflecting the conditions and limitations set by the engineering analysis.

2. Calculation of reduced approach distance values. An employer may take the following steps to reduce minimum approach distances when the maximum transient overvoltage on the system (that is, the maximum transient overvoltage without additional steps to control overvoltages) produces unacceptably large minimum approach distances:

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

Step 2. Determine the technique to use to control the maximum transient overvoltage. (See paragraphs IV.C and IV.D of this appendix.) Determine the maximum transient overvoltage that can exist at the worksite with that form of control in place and with a confidence level of 3s. This voltage is the withstand voltage for the purpose of calculating the appropriate minimum approach distance.

Step 3. Direct employees to implement procedures to ensure that the control technique is in effect during the course of the work.

Step 4. Using the new value of transient overvoltage in per unit, calculate the required minimum approach distance from Table RR-2.

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. For example, the employer can modify the operation of circuit breakers or other switching devices to reduce switching transient overvoltages. Alternatively, the employer can hold the overvoltage to an acceptable level by installing surge arresters or portable protective gaps on the system. In addition, the employer can change the transmission system to minimize the effect of switching operations. Section 4.8 of IEEE Std 516-2009 describes various ways of controlling, and thereby reducing, maximum transient overvoltages.

2. Operation of circuit breakers.[7] The maximum transient overvoltage that can reach the worksite is often the result of switching on the line on which employees are working. Disabling automatic reclosing during energized line work, so that the line will not be reenergized after being opened for any reason, limits the maximum switching surge overvoltage to the larger of the opening surge or the greatest possible fault-generated surge, provided that the devices (for example, insertion resistors) are operable and will function to limit the transient overvoltage and that circuit breaker restrikes do not occur. The employer must ensure the proper functioning of insertion resistors and other overvoltage-limiting devices when the employer's engineering analysis assumes their proper operation to limit the overvoltage level. If the employer cannot disable the reclosing feature (because of system operating conditions), other methods of controlling the switching surge level may be necessary.

Transient surges on an adjacent line, particularly for double circuit construction, may cause a significant overvoltage on the line on which employees are working. The employer's engineering analysis must account for coupling to adjacent lines.

3. Surge arresters. The use of modern surge arresters allows a reduction in the basic impulse-insulation levels of much transmission system equipment. The primary function of early arresters was to protect the system insulation from the effects of lightning. Modern arresters not only dissipate lightning-caused transients, but may also control many other system transients caused by switching or faults.

The employer may use properly designed arresters to control transient overvoltages along a transmission line and thereby reduce the requisite length of the insulator string and possibly the maximum transient overvoltage on the line.[8]

4. Switching Restrictions. Another form of overvoltage control involves establishing switching restrictions, whereby the employer prohibits the operation of circuit breakers until certain system conditions are present. The employer restricts switching by using a tagging system, similar to that used for a permit, except that the common term used for this activity is a "hold-off" or "restriction." These terms indicate that the restriction does not prevent operation, but only modifies the operation during the livework activity.

D. Minimum Approach Distance Based on Control of Maximum Transient Overvoltage at the Worksite

When the employer institutes control of maximum transient overvoltage at the worksite by installing portable protective gaps, the employer may calculate the minimum approach distance as follows:

Step 1. Select the appropriate withstand voltage for the protective gap based on system requirements and an acceptable probability of gap sparkover.[9]

Step 2. Determine a gap distance that provides a withstand voltage[10] greater than or equal to the one selected in the first step.[11]

Step 3. Use 110 percent of the gap's critical sparkover voltage to determine the phase-to-ground peak voltage at gap sparkover (VPPG Peak).

Step 4. Determine the maximum transient overvoltage, phase-to-ground, at the worksite from the following formula:

$$T = \frac{V_{PPG\,Peak}}{V_{L\text{-}G}\sqrt{2}}.$$

Step 5. Use this value of T12 in the equation in Table RR-2 to obtain the minimum approach distance. If the worksite is no more than 900 meters (3,000 feet) above sea level, the employer may use this value of T to determine the minimum approach distance from Table 14 through Table 21.

Note: All rounding must be to the next higher value (that is, always round up).

Sample protective gap calculations.

Problem: Employees are to perform work on a 500-kilovolt transmission line at sea level that is subject to transient overvoltages of 2.4 p.u. The maximum operating voltage of the line is 550 kilovolts. Determine the length of the protective gap that will provide the minimum practical safe approach distance. Also, determine what that minimum approach distance is

Step 1. Calculate the smallest practical maximum transient overvoltage (1.25 times the crest phase-to-ground voltage): [13]

$$550kV \times \frac{\sqrt{2}}{\sqrt{3}} \times 1.25 = 561kV.$$

This value equals the withstand voltage of the protective gap.

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

$$561\text{kV} \div 0.85 = 660\text{kV}$$

For example, if a protective gap with a 1.22-m (4.0-foot) spacing tested to a critical sparkover voltage of 665 kilovolts (crest), select this gap spacing.

Step 3. The phase-to-ground peak voltage at gap sparkover (VPPG Peak) is 110 percent of the value from the previous step:

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

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

Step 4. Use this voltage to determine the worksite value of T:

$$T = \frac{732}{564} = 1.7\,p.u.$$

Step 5. Use this value of T in the equation in Table RR-2 to obtain the minimum approach distance, or look up the minimum approach distance in Table 14 through Table 21:

MAD = 2.29m (7.6 ft).

E. Location of Protective Gaps

1. Adjacent structures. The employer may install the protective gap on a structure adjacent to the worksite, as this practice does not significantly reduce the protection afforded by the gap.

2. Terminal stations. Gaps installed at terminal stations of lines or circuits provide a level of protection; however, that level of protection may not extend throughout the length of the line to the worksite. The use of substation terminal gaps raises the possibility that separate surges could enter the line at opposite ends, each with low enough magnitude to pass the terminal gaps without sparkover. When voltage surges occur simultaneously at each end of a line and travel toward each other, the total voltage on the line at the point where they meet is the arithmetic sum of the two surges. A gap installed within 0.8 km (0.5 mile) of the worksite will protect against such intersecting waves. Engineering studies of a particular line or system may indicate that employers can adequately protect employees by installing gaps at even more distant locations. In any event, unless using the default values for T from Table RR-8, the employer must determine T at the worksite.

3. Worksite. If the employer installs protective gaps at the worksite, the gap setting establishes the worksite impulse insulation strength. Lightning strikes as far as 6 miles from the worksite can cause a voltage surge greater than the gap withstand voltage, and a gap sparkover can occur. In addition, the gap can sparkover from overvoltages on the line that exceed the withstand voltage of the gap. Consequently, the employer must protect employees from hazards resulting from any sparkover that could occur.

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

To prevent reenergization of a circuit faulted during the work, which could create a hazard or result in more serious injuries or damage than the injuries or damage produced by the original fault;

To prevent any transient overvoltage caused by the switching surge that would result if the circuit were reenergized.

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

V. Minimum Approach-Distance Tables

A. Alternative minimum approach distances. Employers may use the minimum approach distances in Table 14 through Table 21 provided that the employer follows the notes to those tables.

TABLE 14 - AC MINIMUM APPROACH DISTANCES-72.6 TO 121.0 KV				
T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	0.67	2.2	0.84	2.8
1.6	0.69	2.3	0.87	2.9
1.7	0.71	2.3	0.90	3.0
1.8	0.74	2.4	0.93	3.1
1.9	0.76	2.5	0.96	3.1
2.0	0.78	2.6	0.99	3.2
2.1	0.81	2.7	1.01	3.3
2.2	0.83	2.7	1.04	3.4
2.3	0.85	2.8	1.07	3.5
2.4	0.88	2.9	1.10	3.6
2.5	0.90	3.0	1.13	3.7
2.6	0.92	3.0	1.16	3.8
2.7	0.95	3.1	1.19	3.9
2.8	0.97	3.2	1.22	4.0
2.9	0.99	3.2	1.24	4.1
3.0	1.02	3.3	1.27	4.2
3.1	1.04	3.4	1.30	4.3
3.2	1.06	3.5	1.33	4.4
3.3	1.09	3.6	1.36	4.5
3.4	1.11	3.6	1.39	4.6
3.5	1.13	3.7	1.42	4.7

TABLE 15 - AC MINIMUM APPROACH DISTANCES – 121.1 TO 145.0 KV				
T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	0.74	2.4	0.95	3.1
1.6	0.76	2.5	0.98	3.2
1.7	0.79	2.6	1.02	3.3
1.8	0.82	2.7	1.05	3.4
1.9	0.85	2.8	1.08	3.5
2.0	0.88	2.9	1.12	3.7
2.1	0.90	3.0	1.15	3.8
2.2	0.93	3.1	1.19	3.9
2.3	0.96	3.1	1.22	4.0
2.4	0.99	3.2	1.26	4.1
2.5	1.02	3.3	1.29	4.2
2.6	1.04	3.4	1.33	4.4
2.7	1.07	3.5	1.36	4.5
2.8	1.10	3.6	1.39	4.6
2.9	1.13	3.7	1.43	4.7
3.0	1.16	3.8	1.46	4.8
3.1	1.19	3.9	1.50	4.9
3.2	1.21	4.0	1.53	5.0
3.3	1.24	4.1	1.57	5.2
3.4	1.27	4.2	1.60	5.2
3.5	1.30	4.3	1.64	5.4

TABLE 16 - AC MINIMUM APPROACH DISTANCES – 145.1 TO 169.0 KV				
T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	0.81	2.7	1.05	3.4
1.6	0.84	2.8	1.09	3.6
1.7	0.87	2.9	1.13	3.7
1.8	0.90	3.0	1.17	3.8
1.9	0.94	3.1	1.21	4.0
2.0	0.97	3.2	1.25	4.1
2.1	1.00	3.3	1.29	4.2
2.2	1.03	3.4	1.33	4.4
2.3	1.07	3.5	1.37	4.5
2.4	1.10	3.6	1.41	4.6
2.5	1.13	3.7	1.45	4.8
2.6	1.17	3.8	1.49	4.9
2.7	1.20	3.9	1.53	5.0
2.8	1.23	4.0	1.57	5.2
2.9	1.26	4.1	1.61	5.3
3.0	1.30	4.3	1.65	5.4
3.1	1.33	4.4	1.70	5.6
3.2	1.36	4.5	1.76	5.8
3.3	1.39	4.6	1.82	6.0
3.4	1.43	4.7	1.88	6.2
3.5	1.46	4.8	1.94	6.4

TABLE 17 - AC MINIMUM APPROACH DISTANCES – 169.1 TO 242.0 KV				
T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	1.02	3.3	1.37	4.5
1.6	1.06	3.5	1.43	4.7
1.7	1.11	3.6	1.48	4.9
1.8	1.16	3.8	1.54	5.1
1.9	1.21	4.0	1.60	5.2
2.0	1.25	4.1	1.66	5.4
2.1	1.30	4.3	1.73	5.7
2.2	1.35	4.4	1.81	5.9
2.3	1.39	4.6	1.90	6.2
2.4	1.44	4.7	1.99	6.5
2.5	1.49	4.9	2.08	6.8
2.6	1.53	5.0	2.17	7.1
2.7	1.58	5.2	2.26	7.4
2.8	1.63	5.3	2.36	7.7
2.9	1.67	5.5	2.45	8.0
3.0	1.72	5.6	2.55	8.4
3.1	1.77	5.8	2.65	8.7
3.2	1.81	5.9	2.76	9.1
3.3	1.88	6.2	2.86	9.4
3.4	1.95	6.4	2.97	9.7
3.5	2.01	6.6	3.08	10.1

TABLE 18 - AC MINIMUM APPROACH DISTANCES – 242.1 TO 362.0 KV				
T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	1.37	4.5	1.99	6.5
1.6	1.44	4.7	2.13	7.0
1.7	1.51	5.0	2.27	7.4
1.8	1.58	5.2	2.41	7.9
1.9	1.65	5.4	2.56	8.4
2.0	1.72	5.6	2.71	8.9
2.1	1.79	5.9	2.87	9.4
2.2	1.87	6.1	3.03	9.9
2.3	1.97	6.5	3.20	10.5
2.4	2.08	6.8	3.37	11.0
2.5	2.19	7.2	3.55	11.6
2.6	2.29	7.5	3.73	12.2
2.7	2.41	7.9	3.91	12.8
2.8	2.52	8.3	4.10	13.5
2.9	2.64	8.7	4.29	14.1
3.0	2.76	9.1	4.49	14.7
3.1	2.88	9.4	4.69	15.4
3.2	3.01	9.9	4.90	16.1
3.3	3.14	10.3	5.11	16.8
3.4	3.27	10.7	5.32	17.5
3.5	3.41	11.2	5.52	18.1

TABLE 19 - AC MINIMUM APPROACH DISTANCES – 362.1 TO 420.0 KV				
T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	1.53	5.0	2.40	7.9
1.6	1.62	5.3	2.58	8.5
1.7	1.70	5.6	2.75	9.0
1.8	1.78	5.8	2.94	9.6
1.9	1.88	6.2	3.13	10.3
2.0	1.99	6.5	3.33	10.9
2.1	2.12	7.0	3.53	11.6
2.2	2.24	7.3	3.74	12.3
2.3	2.37	7.8	3.95	13.0
2.4	2.50	8.2	4.17	13.7
2.5	2.64	8.7	4.40	14.4
2.6	2.78	9.1	4.63	15.2
2.7	2.93	9.6	4.87	16.0
2.8	3.07	10.1	5.11	16.8
2.9	3.23	10.6	5.36	17.6
3.0	3.38	11.1	5.59	18.3
3.1	3.55	11.6	5.82	19.1
3.2	3.72	12.2	6.07	19.9
3.3	3.89	12.8	6.31	20.7
3.4	4.07	13.4	6.56	21.5
3.5	4.25	13.9	6.81	22.3

TABLE 20 - AC MINIMUM APPROACH DISTANCES – 420.1 TO 550.0 KV				
T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	1.95	6.4	3.46	11.4
1.6	2.11	6.9	3.73	12.2
1.7	2.28	7.5	4.02	13.2
1.8	2.45	8.0	4.31	14.1
1.9	2.62	8.6	4.61	15.1
2.0	2.81	9.2	4.92	16.1
2.1	3.00	9.8	5.25	17.2
2.2	3.20	10.5	5.55	18.2
2.3	3.40	11.2	5.86	19.2
2.4	3.62	11.9	6.18	20.3
2.5	3.84	12.6	6.50	21.3
2.6	4.07	13.4	6.83	22.4
2.7	4.31	14.1	7.18	23.6
2.8	4.56	15.0	7.52	24.7
2.9	4.81	15.8	7.88	25.9
3.0	5.07	16.6	8.24	27.0

TABLE 21 - AC MINIMUM APPROACH DISTANCES – 550.1 TO 800.0 KV				
T (p.u.)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
1.5	3.16	10.4	5.97	19.6
1.6	3.46	11.4	6.43	21.1
1.7	3.78	12.4	6.92	22.7
1.8	4.12	13.5	7.42	24.3
1.9	4.47	14.7	7.93	26.0
2.0	4.83	15.8	8.47	27.8
2.1	5.21	17.1	9.02	29.6
2.2	5.61	18.4	9.58	31.4
2.3	6.02	19.8	10.16	33.3
2.4	6.44	21.1	10.76	35.3
2.5	6.88	22.6	11.38	37.3

Notes to Table 14 through Table 21:

The employer must determine the maximum anticipated per-unit transient overvoltage, phase-to-ground, through an engineering analysis, as required by 437-002-2311(3)(b), or assume a maximum anticipated per-unit transient overvoltage, phase-to-ground, in accordance with Table RR-8.

For phase-to-phase exposures, the employer must demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap.

The worksite must be at an elevation of 900 meters (3,000 feet) or less above sea level.

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[1] Federal, State, and local regulatory bodies and electric utilities set reliability requirements that limit the number and duration of system outages.

[2] Sparkover is a disruptive electric discharge in which an electric arc forms and electric current passes through air.

[3] The withstand voltage is the voltage at which sparkover is not likely to occur across a specified distance. It is the voltage taken at the 3s point below the sparkover voltage, assuming that the sparkover curve follows a normal distribution.

[4] Test data demonstrates that the saturation factor is greater than 0 at peak voltages of about 630 kilovolts. Systems operating at 345 kilovolts (or maximum system voltages of 362 kilovolts) can have peak maximum transient overvoltages exceeding 630 kilovolts. Table RR-2 sets equations for calculating a based on peak voltage.

[5] For voltages of 50 to 300 volts, Table RR-2 specifies a minimum approach distance of "avoid contact." The minimum approach distance for this voltage range contains neither an electrical component nor an ergonomic component.

[6] For the purposes of estimating arc length, Division 2/RR generally assumes a more conservative dielectric strength of 10 kilovolts per 25.4 millimeters, consistent with assumptions made in consensus standards such as the National Electrical Safety Code (IEEE C2-2012). The more conservative value accounts for variables such as electrode shape, wave shape, and a certain amount of overvoltage.

[7] The detailed design of a circuit interrupter, such as the design of the contacts, resistor insertion, and breaker timing control, are beyond the scope of this appendix. The design of the system generally accounts for these features. This appendix only discusses features that can limit the maximum switching transient overvoltage on a system.

[8] Surge arrester application is beyond the scope of this appendix. However, if the employer installs the arrester near the work site, the application would be similar to the protective gaps discussed in paragraph IV.D of this appendix.

[9] The employer should check the withstand voltage to ensure that it results in a probability of gap flashover that is acceptable from a system outage perspective. (In other words, a gap sparkover will produce a system outage. The employer should determine whether such an outage will impact overall system performance to an acceptable degree.) In general, the withstand voltage should be at least 1.25 times the maximum crest operating voltage.

[10] The manufacturer of the gap provides, based on test data, the critical sparkover voltage for each gap spacing (for example, a critical sparkover voltage of 665 kilovolts for a gap spacing of 1.2 meters). The withstand voltage for the gap is equal to 85 percent of its critical sparkover voltage.

[11] Switch steps 1 and 2 if the length of the protective gap is known.

[12] IEEE Std 516-2009 states that most employers add 0.2 to the calculated value of T as an additional safety factor.

[13] To eliminate sparkovers due to minor system disturbances, the employer should use a withstand voltage no lower than 1.25 p.u. Note that this is a practical, or operational, consideration only. It may be feasible for the employer to use lower values of withstand voltage.

Appendix C to Division 2/RR –
Protection From Step and Touch Potentials

I. Introduction

Current passing through an impedance impresses voltage across that impedance. Even conductors have some, albeit low, value of impedance. Therefore, if a "grounded" [1] object, such as a crane or deenergized and grounded power line, results in a ground fault on a power line, voltage is impressed on that grounded object. The voltage impressed on the grounded object depends largely on the voltage on the line, on the impedance of the faulted conductor, and on the impedance to "true," or "absolute," ground represented by the object. If the impedance of the object causing the fault is relatively large, the voltage impressed on the object is essentially the phase-to-ground system voltage. However, even faults to grounded power lines or to well grounded transmission towers or substation structures (which have relatively low values of impedance to ground) can result in hazardous voltages.[2] In all cases, the degree of the hazard depends on the magnitude of the current through the employee and the time of exposure. This appendix discusses methods of protecting workers against the possibility that grounded objects, such as cranes and other mechanical equipment, will contact energized power lines and that deenergized and grounded power lines will become accidentally energized.

II. Voltage-Gradient Distribution

A. *Voltage-gradient distribution curve.* Absolute, or true, ground serves as a reference and always has a voltage of 0 volts above ground potential. Because there is an impedance between a grounding electrode and absolute ground, there will be a voltage difference between the grounding electrode and absolute ground under ground-fault conditions. Voltage dissipates from the grounding electrode (or from the grounding point) and creates a ground potential gradient. The voltage decreases rapidly with increasing distance from the grounding electrode. A voltage drop associated with this dissipation of voltage is a ground potential. Figure 1 is a typical voltage-gradient distribution curve (assuming a uniform soil texture).

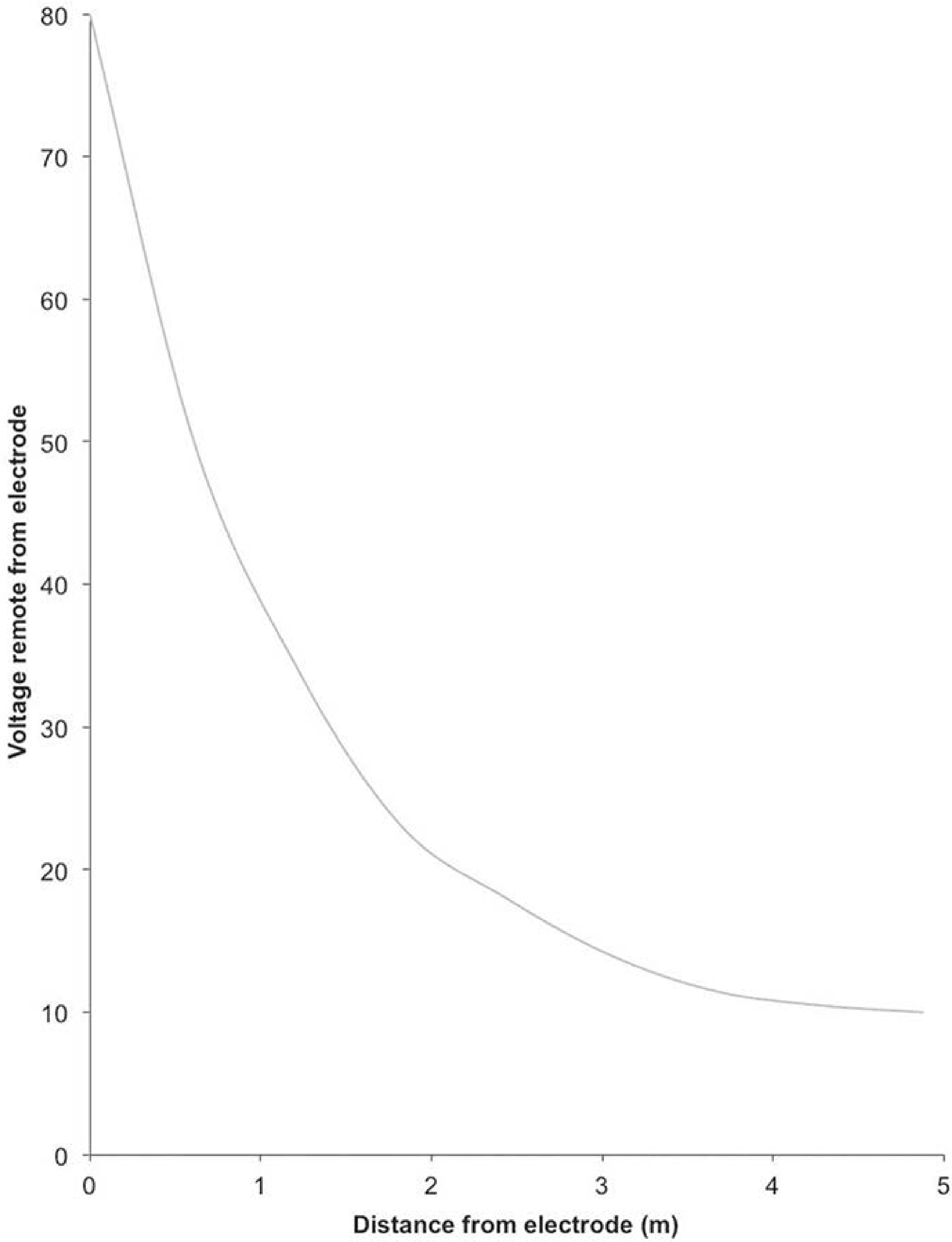

Figure 1 - Typical Voltage - Gradient Distribution Curve

B. *Step and touch potentials.* Figure 1 also shows that workers are at risk from step and touch potentials. Step potential is the voltage between the feet of a person standing near an energized grounded object (the electrode). In Figure 1, the step potential is equal to the difference in voltage between two points at different distances from the electrode (where the points represent the location of each foot in relation to the electrode). A person could be at risk of injury during a fault simply by standing near the object.

Touch potential is the voltage between the energized grounded object (again, the electrode) and the feet of a person in contact with the object. In Figure 1, the touch potential is equal to the difference in voltage between the electrode (which is at a distance of 0 meters) and a point some distance away from the electrode (where the point represents the location of the feet of the person in contact with the object). The touch potential could be nearly the full voltage across the grounded object if that object is grounded at a point remote from the place where the person is in contact with it. For example, a crane grounded to the system neutral and that contacts an energized line would expose any person in contact with the crane or its uninsulated load line to a touch potential nearly equal to the full fault voltage.

Figure 2 illustrates step and touch potentials.

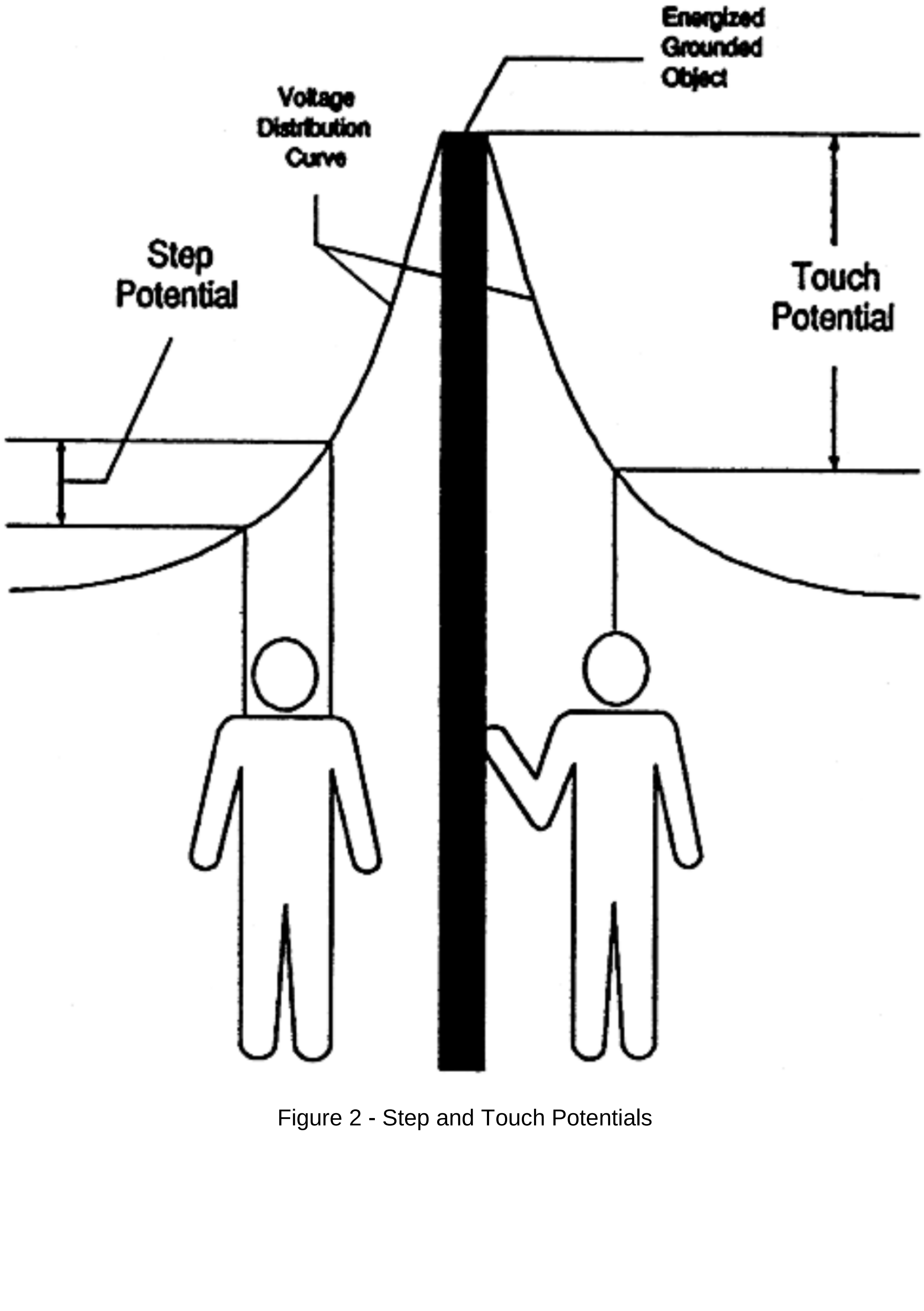

Figure 2 - Step and Touch Potentials

III. Protecting Workers From Hazardous Differences in Electrical Potential

A. *Definitions.* The following definitions apply to section III of this appendix:

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

Bonding cable (bonding jumper). A cable connected to two conductive parts to bond the parts together.

Cluster bar. A terminal temporarily attached to a structure that provides a means for the attachment and bonding of grounding and bonding cables to the structure.

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

Grounding cable (grounding jumper). A cable connected between a deenergized part and ground. Note that grounding cables carry fault current and bonding cables generally do not. A cable that bonds two conductive parts but carries substantial fault current (for example, a jumper connected between one phase and a grounded phase) is a grounding cable.

Ground mat (grounding grid). A temporarily or permanently installed metallic mat or grating that establishes an equipotential surface and provides connection points for attaching grounds.

B. *Analyzing the hazard.* The employer can use an engineering analysis of the power system under fault conditions to determine whether hazardous step and touch voltages will develop. The analysis should determine the voltage on all conductive objects in the work area and the amount of time the voltage will be present. Based on the this analysis, the employer can select appropriate measures and protective equipment, including the measures and protective equipment outlined in Section III of this appendix, to protect each employee from hazardous differences in electric potential. For example, from the analysis, the employer will know the voltage remaining on conductive objects after employees install bonding and grounding equipment and will be able to select insulating equipment with an appropriate rating, as described in paragraph III.C.2 of this appendix.

C. *Protecting workers on the ground.* The employer may use several methods, including equipotential zones, insulating equipment, and restricted work areas, to protect employees on the ground from hazardous differences in electrical potential.

1. An equipotential zone will protect workers within it from hazardous step and touch potentials. (See Figure 3.) Equipotential zones will not, however, protect employees located either wholly or partially outside the protected area. The employer can establish an equipotential zone for workers on the ground, with respect to a grounded object, through the use of a metal mat connected to the grounded object. The employer can use a grounding grid to equalize the voltage within the grid or bond conductive objects in the immediate work area to minimize the potential between the objects and between each object and ground. (Bonding an object outside the work area can increase the touch potential to that object, however.) Section III.D of this appendix discusses equipotential zones for employees working on deenergized and grounded power lines.

2. 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 performing the operation. The employer must ensure that employees on the ground in the vicinity of transmission structures are at a distance where step voltages would be insufficient to cause injury. Employees must not handle grounded conductors or equipment likely to become energized to hazardous voltages unless the employees are within an equipotential zone or protected by insulating equipment.

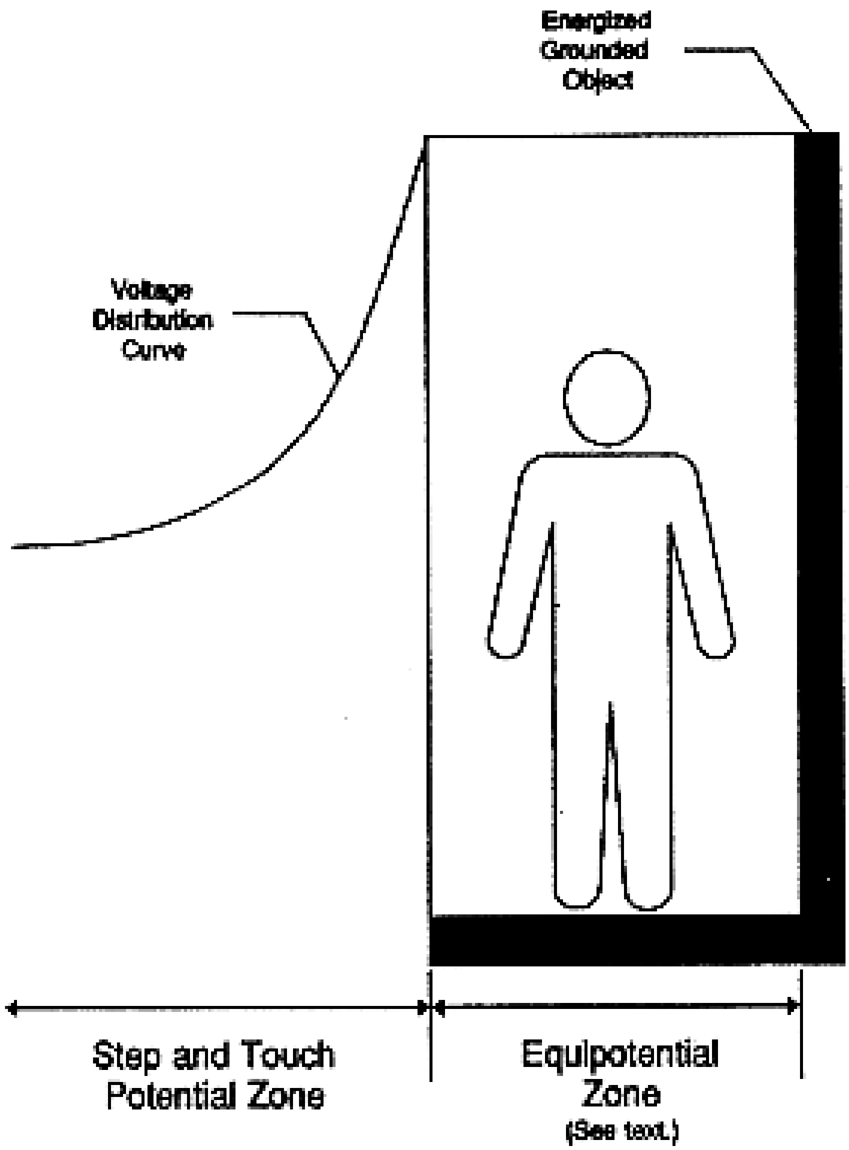

Figure 3 - Protection from Ground-Potential Gradients

D. *Protecting employees working on deenergized and grounded power lines*. This Section III.D of Appendix C establishes guidelines to help employers comply with requirements in 437-002-2313 for using protective grounding to protect employees working on deenergized power lines. 437-002-2313 applies to grounding of transmission and distribution lines and equipment for the purpose of protecting workers. 437-002-2313(3) requires temporary protective grounds to be placed at such locations and arranged in such a manner that the employer can demonstrate will prevent exposure of each employee to hazardous differences in electric potential.[3] Sections III.D.1 and III.D.2 of this appendix provide guidelines that employers can use in making the demonstration required by 437-002-2313(3). Section III.D.1 of this appendix provides guidelines on how the employer can determine whether particular grounding practices expose employees to hazardous differences in electric potential. Section III.D.2 of this appendix describes grounding methods that the employer can use in lieu of an engineering analysis to make the demonstration required by 437-002-2313(3). Oregon OSHA will consider employers that comply with the criteria in this appendix as meeting 437-002-2313(3).

Finally, Section III.D.3 of this appendix discusses other safety considerations that will help the employer comply with other requirements in 437-002-2313. Following these guidelines will protect workers from hazards that can occur when a deenergized and grounded line becomes energized.

1. *Determining safe body current limits*. This Section III.D.1 of Appendix C provides guidelines on how an employer can determine whether any differences in electric potential to which workers could be exposed are hazardous as part of the demonstration required by 437-002-2313(3).

Institute of Electrical and Electronic Engineers (IEEE) Standard 1048-2003, IEEE Guide for Protective Grounding of Power Lines, provides the following equation for determining the threshold of ventricular fibrillation when the duration of the electric shock is limited:

$$I = \frac{116}{\sqrt{t}},$$

where *I* is the current through the worker's body, and t is the duration of the current in seconds. This equation represents the ventricular fibrillation threshold for 95.5 percent of the adult population with a mass of 50 kilograms (110 pounds) or more. The equation is valid for current durations between 0.0083 to 3.0 seconds.

To use this equation to set safe voltage limits in an equipotential zone around the worker, the employer will need to assume a value for the resistance of the worker's body. IEEE Std 1048-2003 states that "total body resistance is usually taken as 1000 Ω for determining . . . body current limits." However, employers should be aware that the impedance of a worker's body can be substantially less than that value. For instance, IEEE Std 1048-2003 reports a minimum hand-to-hand resistance of 610 ohms and an internal body resistance of 500 ohms. The internal resistance of the body better represents the minimum resistance of a worker's body when the skin resistance drops near zero, which occurs, for example, when there are breaks in the worker's skin, for instance, from cuts or from blisters formed as a result of the current from an electric shock, or when the worker is wet at the points of contact.

Employers may use the IEEE Std 1048-2003 equation to determine safe body current limits only if the employer protects workers from hazards associated with involuntary muscle reactions from electric shock (for example, the hazard to a worker from falling as a result of an electric shock). Moreover, the equation applies only when the duration of the electric shock is limited. If the precautions the employer takes, including those required by applicable standards, do not adequately protect employees from hazards associated with involuntary reactions from electric shock, a hazard exists if the induced voltage is sufficient to pass a current of 1 milliampere through a 500-ohm resistor. (The 500-ohm resistor represents the resistance of an employee. The 1-milliampere current is the threshold of perception.) Finally, if the employer protects employees from injury due to involuntary reactions from electric shock, but the duration of the electric shock is unlimited (that is, when the fault current at the work location will be insufficient to trip the devices protecting the circuit), a hazard exists if the resultant current would be more than 6 milliamperes (the recognized let-go threshold for workers [4]).

2. *Acceptable methods of grounding for employers that do not perform an engineering determination*. The grounding methods presented in this section of this appendix ensure that differences in electric potential are as low as possible and, therefore, meet 437-002-2313(3) without an engineering determination of the potential differences. These methods follow two principles: (i) The grounding method must ensure that the circuit opens in the fastest available clearing time, and (ii) the grounding method must ensure that the potential differences between conductive objects in the employee's work area are as low as possible.

437-002-2313(3) does not require grounding methods to meet the criteria embodied in these principles. Instead, the paragraph requires that protective grounds be "placed at such locations and arranged in such a manner that the employer can demonstrate will prevent exposure of each employee to hazardous differences in electric potential." However, when the employer's grounding practices do not follow these two principles, the employer will need to perform an engineering analysis to make the demonstration required by 437-002-2313(3).

i. *Ensuring that the circuit opens in the fastest available clearing time*. Generally, the higher the fault current, the shorter the clearing times for the same type of fault. Therefore, to ensure the fastest available clearing time, the grounding method must maximize the fault current with a low impedance connection to ground. The employer accomplishes this objective by grounding the circuit conductors to the best ground available at the worksite. Thus, the employer must ground to a grounded system neutral conductor, if one is present. A grounded system neutral has a direct connection to the system ground at the source, resulting in an extremely low impedance to ground. In a substation, the employer may instead ground to the substation grid, which also has an extremely low impedance to the system ground and, typically, is connected to a grounded system neutral when one is present. Remote system grounds, such as pole and tower grounds, have a higher impedance to the system ground than grounded system neutrals and substation grounding grids; however, the employer may use a remote ground when lower impedance grounds are not available. In the absence of a grounded system neutral, substation grid, and remote ground, the employer may use a temporary driven ground at the worksite.

In addition, if employees are working on a three-phase system, the grounding method must short circuit all three phases. Short circuiting all phases will ensure faster clearing and lower the current through the grounding cable connecting the deenergized line to ground, thereby lowering the voltage across that cable. The short circuit need not be at the worksite; however, the employer must treat any conductor that is not grounded at the worksite as energized because the ungrounded conductors will be energized at fault voltage during a fault.

ii. *Ensuring that the potential differences between conductive objects in the employee's work area are as low as possible*. To achieve as low a voltage as possible across any two conductive objects in the work area, the employer must bond all conductive objects in the work area. This section of this appendix discusses how to create a zone that minimizes differences in electric potential between conductive objects in the work area.

The employer must use bonding cables to bond conductive objects, except for metallic objects bonded through metal-to-metal contact. The employer must ensure that metal-to-metal contacts are tight and free of contamination, such as oxidation, that can increase the impedance across the connection. For example, a bolted connection between metal lattice tower members is acceptable if the connection is tight and free of corrosion and other contamination. Figure 4 shows how to create an equipotential zone for metal lattice towers.

Wood poles are conductive objects. The poles can absorb moisture and conduct electricity, particularly at distribution and transmission voltages. Consequently, the employer must either: (1) Provide a conductive platform, bonded to a grounding cable, on which the worker stands or (2) use cluster bars to bond wood poles to the grounding cable. The employer must ensure that employees install the cluster bar below, and close to, the worker's feet. The inner portion of the wood pole is more conductive than the outer shell, so it is important that the cluster bar be in conductive contact with a metal spike or nail that penetrates the wood to a depth greater than or equal to the depth the worker's climbing gaffs will penetrate the wood. For example, the employer could mount the cluster bar on a bare pole ground wire fastened to the pole with nails or staples that penetrate to the required depth. Alternatively, the employer may temporarily nail a conductive strap to the pole and connect the strap to the cluster bar. Figure 5 shows how to create an equipotential zone for wood poles.

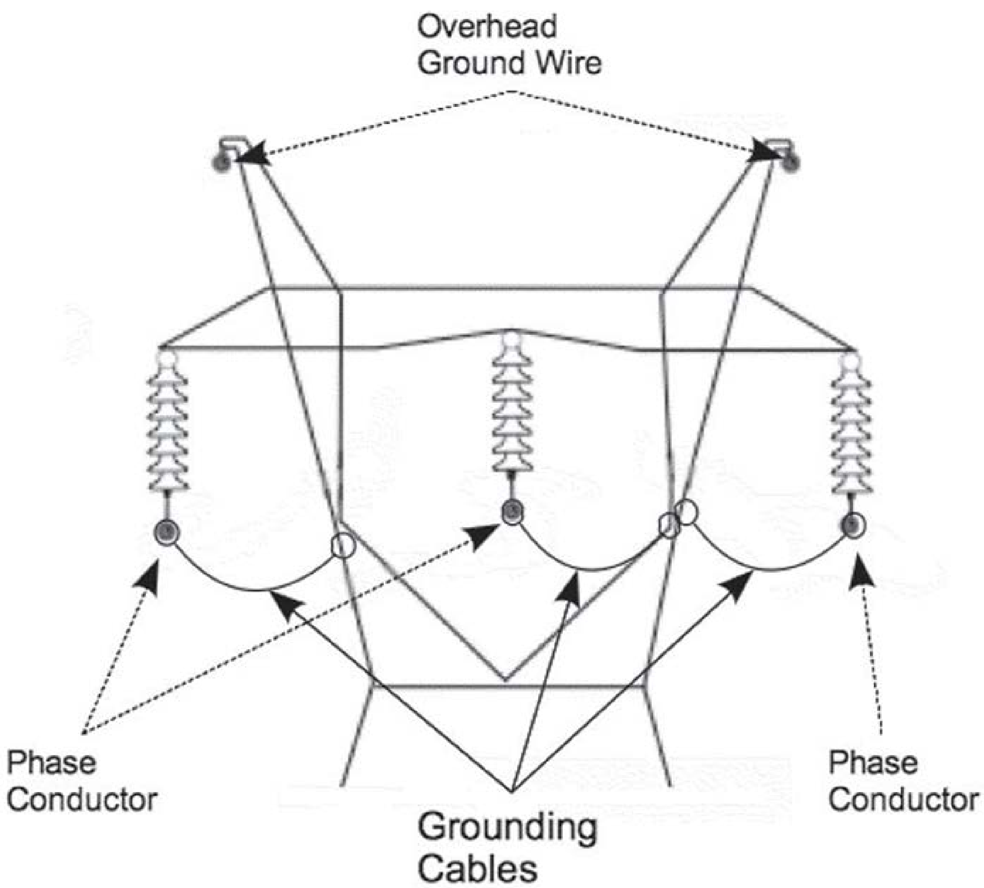

Figure 4 - Equipotential Zone for Metal Lattice Tower

Notes:

1. Employers must ground overhead ground wires that are within reach of the employee.

2. The grounding cable must be as short as practicable; therefore, the attachment points between the grounding cable and the tower may be different from that shown in the figure.

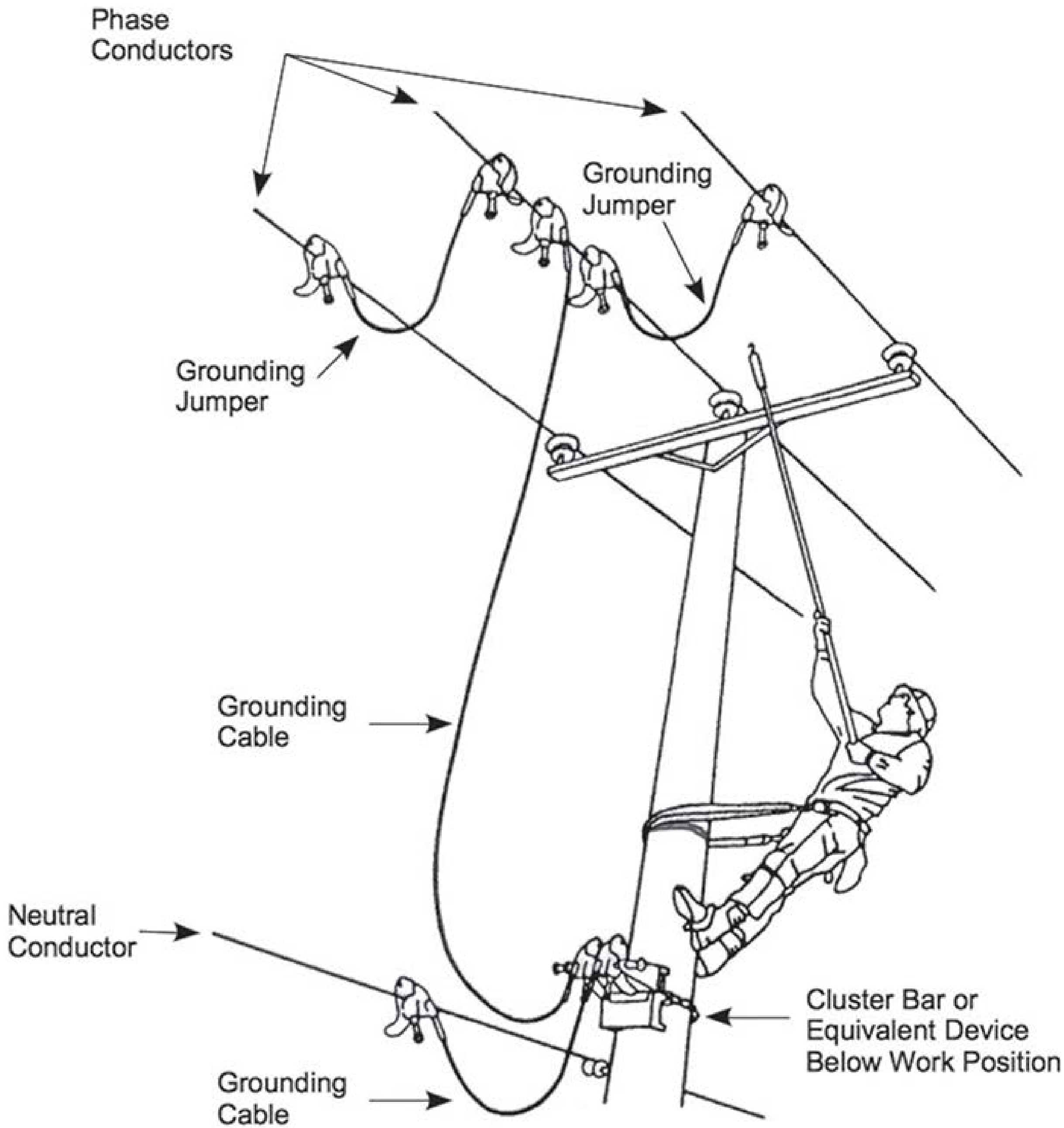

Figure 5 - Equipotential Grounding for Wood Poles

Figure reprinted with permission from Hubbell Power Systems, Inc. (Hubbell)

OSHA revised the figure from Hubbell's original.

For underground systems, employers commonly install grounds at the points of disconnection of the underground cables. These grounding points are typically remote from the manhole or underground vault where employees will be working on the cable. Workers in contact with a cable grounded at a remote location can experience hazardous potential differences if the cable becomes energized or if a fault occurs on a different, but nearby, energized cable. The fault current causes potential gradients in the earth, and a potential difference will exist between the earth where the worker is standing and the earth where the cable is grounded. Consequently, to create an equipotential zone for the worker, the employer must provide a means of connecting the deenergized cable to ground at the worksite by having the worker stand on a conductive mat bonded to the deenergized cable. If the cable is cut, the employer must install a bond across the opening in the cable or install one bond on each side of the opening to ensure that the separate cable ends are at the same potential. The employer must protect the worker from any hazardous differences in potential any time there is no bond between the mat and the cable (for example, before the worker installs the bonds).

3. *Other safety-related considerations*. To ensure that the grounding system is safe and effective, the employer should also consider the following factors: [5]

i. *Maintenance of grounding equipment*. It is essential that the employer properly maintain grounding equipment. Corrosion in the connections between grounding cables and clamps and on the clamp surface can increase the resistance of the cable, thereby increasing potential differences. In addition, the surface to which a clamp attaches, such as a conductor or tower member, must be clean and free of corrosion and oxidation to ensure a low-resistance connection. Cables must be free of damage that could reduce their current-carrying capacity so that they can carry the full fault current without failure. Each clamp must have a tight connection to the cable to ensure a low resistance and to ensure that the clamp does not separate from the cable during a fault.

ii. *Grounding cable length and movement*. The electromagnetic forces on grounding cables during a fault increase with increasing cable length. These forces can cause the cable to move violently during a fault and can be high enough to damage the cable or clamps and cause the cable to fail. In addition, flying cables can injure workers. Consequently, cable lengths should be as short as possible, and grounding cables that might carry high fault current should be in positions where the cables will not injure workers during a fault.

[1] This appendix generally uses the term "grounded" only with respect to grounding that the employer intentionally installs, for example, the grounding an employer installs on a deenergized conductor. However, in this case, the term "grounded" means connected to earth, regardless of whether or not that connection is intentional.

[2] Thus, grounding systems for transmission towers and substation structures should be designed to minimize the step and touch potentials involved.

[3] The protective grounding required by 437-002-2313 limits to safe values the potential differences between accessible objects in each employee's work environment. Ideally, a protective grounding system would create a true equipotential zone in which every point is at the same electric potential. In practice, current passing through the grounding and bonding elements creates potential differences. If these potential differences are hazardous, the employer may not treat the zone as an equipotential zone.

[4] Electric current passing through the body has varying effects depending on the amount of the current. At the let-go threshold, the current overrides a person's control over his or her muscles. At that level, an employee grasping an object will not be able to let go of the object. The let-go threshold varies from person to person; however, the recognized value for workers is 6 milliamperes.

[5] This appendix only discusses factors that relate to ensuring an equipotential zone for employees. The employer must consider other factors in selecting a grounding system that is capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault, as required by 437-002-2313(4)(a). IEEE Std 1048-2003 contains guidelines for selecting and installing grounding equipment that will meet 437-002-2313(4)(a).

Appendix D to Division 2/RR - Methods of Inspecting and Testing Wood Poles

I. Introduction

When employees are to perform work on a wood pole, it is important to determine the condition of the pole before employees climb it. The weight of the employee, the weight of equipment to be installed, and other working stresses (such as the removal or retensioning of conductors) can lead to the failure of a defective pole or a pole that is not designed to handle the additional stresses.[1] For these reasons, it is essential that, before an employee climbs a wood pole, the employer ascertain that the pole is capable of sustaining the stresses of the work. The determination that the pole is capable of sustaining these stresses includes an inspection of the condition of the pole.

If the employer finds the pole to be unsafe to climb or to work from, the employer must secure the pole so that it does not fail while an employee is on it. The employer can secure the pole 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, employees should work from the new one.

II. Inspecting Wood Poles

A qualified employee should inspect wood poles for the following conditions: [2]

A. *General condition*. Buckling at the ground line or an unusual angle with respect to the ground may indicate that the pole has rotted or is broken.

B. *Cracks*. Horizontal cracks perpendicular to the grain of the wood may weaken the pole. Vertical cracks, although not normally 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 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 depth.

G. *Soil conditions*. Soft, wet, or loose soil around the base of the pole may indicate that the pole will not support any change in stress.

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

III. Testing Wood Poles

The following tests, which are from 1910.268(n)(3), are acceptable methods of testing wood poles:

A. *Hammer test*. Rap the pole sharply with a hammer weighing about 1.4 kg (3 pounds), starting near the ground line and continuing upwards circumferentially around the pole to a height of approximately 1.8 meters (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 127 millimeters (5 inches) long. If substantial decay is present, the pole is 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. Exercise caution to avoid causing power lines to swing together. Apply the force to the pole either by pushing it with a pike pole or pulling the pole with a rope. If the pole cracks during the test, it is unsafe.

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

[2] The 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 it is safe to perform the work without taking additional precautions.

Appendix E to Division 2/RR –
Protection From Flames and Electric Arcs

I. Introduction

437-002-2311(8) addresses protecting employees from flames and electric arcs. This paragraph requires employers to: (1) Assess the workplace for flame and electric-arc hazards (paragraph (8)(a)); (2) estimate the available heat energy from electric arcs to which employees would be exposed (paragraph (8)(b)); (3) ensure that employees wear clothing that will not melt, or ignite and continue to burn, when exposed to flames or the estimated heat energy (paragraph (8)(c)); and (4) ensure that employees wear flame-resistant clothing 1 and protective clothing and other protective equipment that has an arc rating greater than or equal to the available heat energy under certain conditions (paragraphs (8)(d) and (8)(e)). This appendix contains information to help employers estimate available heat energy as required by 437-002-2311(8)(b), select protective clothing and other protective equipment with an arc rating suitable for the available heat energy as required by 437-002-2311(8)(e), and ensure that employees do not wear flammable clothing that could lead to burn injury as addressed by 437-002-2311(8)(c) and (d).

II. Assessing the Workplace for Flame and Electric-Arc Hazards

437-002-2311(8)(a) requires the employer to assess the workplace to identify employees exposed to hazards from flames or from electric arcs. This provision ensures that the employer evaluates employee exposure to flames and electric arcs so that employees who face such exposures receive the required protection. The employer must conduct an assessment for each employee who performs work on or near exposed, energized parts of electric circuits.

A. Assessment Guidelines

Sources electric arcs. Consider possible sources of electric arcs, including:

Energized circuit parts not guarded or insulated,

Switching devices that produce electric arcs in normal operation,

Sliding parts that could fault during operation (for example, rack-mounted circuit breakers), and

Energized electric equipment that could fail (for example, electric equipment with damaged insulation or with evidence of arcing or overheating).

Exposure to flames. Identify employees exposed to hazards from flames. Factors to consider include:

The proximity of employees to open flames, and

For flammable material in the work area, whether there is a reasonable likelihood that an electric arc or an open flame can ignite the material.

Probability that an electric arc will occur. Identify employees exposed to electric-arc hazards. Oregon OSHA will consider an employee exposed to electric-arc hazards if there is a reasonable likelihood that an electric arc will occur in the employee's work area, in other words, if the probability of such an event is higher than it is for the normal operation of enclosed equipment. Factors to consider include:

For energized circuit parts not guarded or insulated, whether conductive objects can come too close to or fall onto the energized parts,

For exposed, energized circuit parts, whether the employee is closer to the part than the minimum approach distance established by the employer (as permitted by 437-002-2311(3)(c)).

Whether the operation of electric equipment with sliding parts that could fault during operation is part of the normal operation of the equipment or occurs during servicing or maintenance, and

For energized electric equipment, whether there is evidence of impending failure, such as evidence of arcing or overheating.

B. Examples

Table 1 provides task-based examples of exposure assessments.

<table>
<tr><th colspan="3">TABLE 1-EXAMPLE ASSESSMENTS FOR VARIOUS TASKS</th></tr>
<tr><th colspan="2">Task</th><th>Is employee exposed to flame or electricarc hazard?</th></tr>
<tr><td rowspan="3">Normal operation of enclosed equipment, such as closing or opening a switch.</td><td>The employer properly installs and maintains enclosed equipment, and there is no evidence of impending failure.</td><td>No</td></tr>
<tr><td>There is evidence of arcing or overheating</td><td>Yes.</td></tr>
<tr><td>Parts of the equipment are loose or sticking, or the equipment otherwise exhibits signs of lack of maintenance.</td><td>Yes.</td></tr>
<tr><td colspan="2">Servicing electric equipment, such as racking in a circuit breaker or replacing a switch</td><td>Yes</td></tr>
<tr><td rowspan="3">Inspection of electric equipment with exposed energized parts.</td><td>The employee is not holding conductive objects and remains outside the minimum approach distance established by the employer.</td><td>No.</td></tr>
<tr><td>The employee is holding a conductive object, such as a flashlight, that could fall or otherwise contact energized parts (irrespective of whether the employee maintains the minimum approach distance).</td><td>Yes.</td></tr>
<tr><td>The employee is closer than the minimum approach distance established by the employer (for example, when wearing rubber insulating gloves or rubber insulating gloves and sleeves).</td><td>Yes.</td></tr>
<tr><td colspan="2">Using open flames, for example, in wiping cable splice sleeves</td><td>Yes</td></tr>
</table>

III. Protection Against Burn Injury

A. Estimating Available Heat Energy

Calculation methods. 437-002-2311(8)(b) provides that, for each employee exposed to an electric-arc hazard, the employer must make a reasonable estimate of the heat energy to which the employee would be exposed if an arc occurs. Table 2 lists various methods of calculating values of available heat energy from an electric circuit. Oregon OSHA does not endorse any of these specific methods. Each method requires the input of various parameters, such as fault current, the expected length of the electric arc, the distance from the arc to the employee, and the clearing time for the fault (that is, the time the circuit protective devices take to open the circuit and clear the fault). The employer can precisely determine some of these parameters, such as the fault current and the clearing time, for a given system. The employer will need to estimate other parameters, such as the length of the arc and the distance between the arc and the employee, because such parameters vary widely.

TABLE 2 - METHODS OF CALCULATING INCIDENT HEAT ENERGY FROM AN ELECTRIC ARC
1. Standard for Electrical Safety Requirements for Employee Workplaces, NFPA 70E-2012, Annex D, "Sample Calculation of Flash Protection Boundary."
2. Doughty, T.E., Neal, T.E., and Floyd II, H.L., "Predicting Incident Energy to Better Manage the Electric Arc Hazard on 600 V Power Distribution Systems," Record of Conference Papers IEEE IAS 45th Annual Petroleum and Chemical Industry Conference, September 28-30, 1998.
3. Guide for Performing Arc-Flash Hazard Calculations, IEEE Std 1584-2002, 1584a-2004 (Amendment 1 to IEEE Std 1584-2002), and 1584b-2011 (Amendment 2: Changes to Clause 4 of IEEE Std 1584-2002).*
4. ARCPRO, a commercially available software program developed by Kinectrics, Toronto, ON, CA.

* This appendix refers to IEEE Std 1584-2002 with both amendments as IEEE Std 1584b-2011.

The amount of heat energy calculated by any of the methods is approximately inversely proportional to the square of the distance between the employee and the arc. In other words, if the employee is very close to the arc, the heat energy is very high; but if the employee is just a few more centimeters away, the heat energy drops substantially. Thus, estimating the distance from the arc to the employee is key to protecting employees.

The employer must select a method of estimating incident heat energy that provides a reasonable estimate of incident heat energy for the exposure involved. Table 3 shows which methods provide reasonable estimates for various exposures.

TABLE 3-SELECTING A REASONABLE INCIDENT-ENERGY CALCULATION METHOD [1]									
Incident-energy calculation method	600 V and Less [2]			601 V to 15 kV [2]			More than 15 Kv		
	1Φ	3Φa	3Φb	1Φ	3Φa	3Φb	1Φ	3Φa	3Φb
NFPA 70E-2012 Annex D (Lee equation)	Y-C	Y	N	Y-C	Y-C	N	N3	N3	N3
Doughty, Neal, and Floyd	Y-C	Y	Y	N	N	N	N	N	N
IEEE Std 1584b-2011	Y	Y	Y	Y	Y	Y	N	N	N
ARCPRO	Y	N	N	Y	N	N	Y	Y4	Y4

Key:
1Φ: Single-phase arc in open air.
3Φa: Three-phase arc in open air.
3Φb: Three-phase arc in an enclosure (box).
Y: Acceptable; produces a reasonable estimate of incident heat energy from this type of electric arc.
N: Not acceptable; does not produce a reasonable estimate of incident heat energy from this type of electric arc.
Y-C: Acceptable; produces a reasonable, but conservative, estimate of incident heat energy from this type of electric arc.

Notes:
[1] Although the Oregon OSHA will consider these methods reasonable for enforcement purposes when employers use the methods in accordance with this table, employers should be aware that the listed methods do not necessarily result in estimates that will provide full protection from internal faults in transformers and similar equipment or from arcs in underground manholes or vaults.

[2] At these voltages, the presumption is that the arc is three-phase unless the employer can demonstrate that only one phase is present or that the spacing of the phases is sufficient to prevent a multiphase arc from occurring.

[3] Although Oregon OSHA will consider this method acceptable for purposes of assessing whether incident energy exceeds 2.0 cal/cm^2, the results at voltages of more than 15 kilovolts are extremely conservative and unrealistic.

[4] Oregon OSHA will deem the results of this method reasonable when the employer adjusts them using the conversion factors for three-phase arcs in open air or in an enclosure, as indicated in the program's instructions.

Selecting a reasonable distance from the employee to the arc. In estimating available heat energy, the employer must make some reasonable assumptions about how far the employee will be from the electric arc. Table 4 lists reasonable distances from the employee to the electric arc. The distances in Table 4 are consistent with national consensus standards, such as the Institute of Electrical and Electronic Engineers' National Electrical Safety Code, ANSI/IEEE C2-2012, and IEEE Guide for Performing Arc-Flash Hazard Calculations, IEEE Std 1584b-2011. The employer is free to use other reasonable distances, but must consider equipment enclosure size and the working distance to the employee in selecting a distance from the employee to the arc. Oregon OSHA will consider a distance reasonable when the employer bases it on equipment size and working distance.

TABLE 4-SELECTING A REASONABLE DISTANCE FROM THE EMPLOYEE TO THE ELECTRIC ARC

Class of equipment	Single-phase arc mm (inches)	Three-phase arc mm (inches)
Cable	*NA	455 (18)
Low voltage MCCs and panelboards	NA	455 (18)
Low-voltage switchgear	NA	610 (24)
5-kV switchgear	NA	910 (36)
15-kV switchgear	NA	910 (36)
Single conductors in air (up to 46 kilovolts), work with rubber insulating gloves	380 (15)	NA
Single conductors in air, work with live-line tools	MAD - (2 × kV × 2.54) (MAD - (2 × kV /10)) †	NA

* NA = not applicable.
† The terms in this equation are:
MAD = The applicable minimum approach distance, and
kV = The system voltage in kilovolts.

Selecting a reasonable arc gap. For a single-phase arc in air, the electric arc will almost always occur when an energized conductor approaches too close to ground. Thus, an employer can determine the arc gap, or arc length, for these exposures by the dielectric strength of air and the voltage on the line. The dielectric strength of air is approximately 10 kilovolts for every 25.4 millimeters (1 inch). For example, at 50 kilovolts, the arc gap would be 50 ÷ 10 × 25.4 (or 50 × 2.54), which equals 127 millimeters (5 inches).

For three-phase arcs in open air and in enclosures, the arc gap will generally be dependent on the spacing between parts energized at different electrical potentials. Documents such as IEEE Std 1584b-2011 provide information on these distances. Employers may select a reasonable arc gap from Table 5, or they may select any other reasonable arc gap based on sparkover distance or on the spacing between (1) live parts at different potentials or (2) live parts and grounded parts (for example, bus or conductor spacings in equipment). In any event, the employer must use an estimate that reasonably resembles the actual exposures faced by the employee.

TABLE 5-SELECTING A REASONABLE ARC GAP

Class of equipment	Single-phase arc mm (inches)	Three-phase arc mm [1] (inches)
Cable	NA[2]	13 (0.5).
Low voltage MCCs and panelboards	NA	25 (1.0).
Low-voltage switchgear	NA	32 (1.25).
5-kV switchgear	NA	104 (4.0).
15-kV switchgear	NA	152 (6.0).
Single conductors in air, 15 kV and less.	51 (2.0)	Phase conductor spacing.
Single conductor in air, more than 15 kV	Voltage in kV × 2.54 (Voltage in kV × 0.1), but no less than 51 mm (2 inches).	Phase conductor spacing.

[1] Source: IEEE Std 1584b-2011.
[2] NA = not applicable.

Making estimates over multiple system areas. The employer need not estimate the heat-energy exposure for every job task performed by each employee. 437-002-2311(8)(b) permits the employer to make broad estimates that cover multiple system areas provided that: (1) The employer uses reasonable assumptions about the energy-exposure distribution throughout the system, and (2) the estimates represent the maximum exposure for those areas. For example, the employer can use the maximum fault current and clearing time to cover several system areas at once.

Incident heat energy for single-phase-to-ground exposures. Table 6 and Table 7 provide incident heat energy levels for open-air, phase-to-ground electric-arc exposures typical for overhead systems.2 Table 6 presents estimates of available energy for employees using rubber insulating gloves to perform work on overhead systems operating at 4 to 46 kilovolts. The table assumes that the employee will be 380 millimeters (15 inches) from the electric arc, which is a reasonable estimate for rubber insulating glove work. Table 6 also assumes that the arc length equals the sparkover distance for the maximum transient overvoltage of each voltage range.3 To use the table, an employer would use the voltage, maximum fault current, and maximum clearing time for a system area and, using the appropriate voltage range and fault-current and clearingtime values corresponding to the next higher values listed in the table, select the appropriate heat energy (4, 5, 8, or 12 cal/cm2) from the table. For example, an employer might have a 12,470-volt power line supplying a system area. The power line can supply a maximum fault current of 8 kiloamperes with a maximum clearing time of 10 cycles. For rubber glove work, this system falls in the 4.0-to-15.0-kilovolt range; the next-higher fault current is 10 kA (the second row in that voltage range); and the clearing time is under 18 cycles (the first column to the right of the fault current column). Thus, the available heat energy for this part of the system will be 4 cal/cm2 or less (from the column heading), and the employer could select protection with a 5-cal/cm2 rating to meet 437-002-2311(8)(e). Alternatively, an employer could select a base incident-energy value and ensure that the clearing times for each voltage range and fault current listed in the table do not exceed the corresponding clearing time specified in the table. For example, an employer that provides employees with arc-flash protective equipment rated at 8 cal/cm2 can use the table to determine if any system area exceeds 8 cal/cm2 by checking the clearing time for the highest fault current for each voltage range and ensuring that the clearing times do not exceed the values specified in the 8-cal/cm2 column in the table.

Table 7 presents similar estimates for employees using live-line tools to perform work on overhead systems operating at voltages of 4 to 800 kilovolts. The table assumes that the arc length will be equal to the sparkover distance4 and that the employee will be a distance from the arc equal to the minimum approach distance minus twice the sparkover distance.

The employer will need to use other methods for estimating available heat energy in situations not addressed by Table 6 or Table 7. The calculation methods listed in Table 2 and the guidance provided in Table 3 will help employers do this. For example, employers can use IEEE Std 1584b-2011 to estimate the available heat energy (and to select appropriate protective equipment) for many specific conditions, including lowervoltage, phase-to-phase arc, and enclosed arc exposures.

TABLE 6 - INCIDENT HEAT ENERGY FOR VARIOUS FAULT CURRENTS, CLEARING TIMES, AND VOLTAGES OF 4.0 TO 46.0 KV: RUBBER INSULATING GLOVE EXPOSURES INVOLVING PHASE-TO-GROUND ARCS IN OPEN AIR ONLY * † ‡					
Voltage range (kV) **	Fault current (kA)	Maximum clearing time (cycles)			
		4 cal/cm^2	5 cal/cm^2	8 cal/cm^2	12 cal/cm^2
4.0 to 15.0	5	46	58	92	138
	10	18	22	36	54
	15	10	12	20	30
	20	6	8	13	19
15.1 to 25.0	5	28	34	55	83
	10	11	14	23	34
	15	7	8	13	20
	20	4	5	9	13
25.1 to 36.0	5	21	26	42	62
	10	9	11	18	26
	15	5	6	10	16
	20	4	4	7	11
36.1 to 46.0	5	16	20	32	48
	10	7	9	14	21
	15	4	5	8	13
	20	3	4	6	9

Notes:

* This table is for open-air, phase-to-ground electric-arc exposures. It is not for phase-to-phase arcs or enclosed arcs (arc in a box).

† The table assumes that the employee will be 380 mm (15 in.) from the electric arc. The table also assumes the arc length to be the sparkover distance for the maximum transient overvoltage of each voltage range (see Appendix B to Division 2/RR), as follows:

4.0 to 15.0 kV 51 mm (2 in.)
15.1 to 25.0 kV 102 mm (4 in.)
25.1 to 36.0 kV 152 mm (6 in.)
36.1 to 46.0 kV 229 mm (9 in.)

‡ The Occupational Safety and Health Administration calculated the values in this table using the ARCPRO method listed in Table 2.

** The voltage range is the phase-to-phase system voltage.

TABLE 7 - INCIDENT HEAT ENERGY FOR VARIOUS FAULT CURRENTS, CLEARING TIMES, AND VOLTAGES: LIVE-LINE TOOL EXPOSURES INVOLVING PHASE-TO-GROUND ARCS IN OPEN AIR ONLY * † ‡ #					
Voltage range (kV) **	Fault current (kA)	Maximum clearing time (cycles)			
		4 cal/cm^2	5 cal/cm^2	8 cal/cm^2	12 cal/cm^2
4.0 to 15.0	5	197	246	394	591
	10	73	92	147	220
	15	39	49	78	117
	20	24	31	49	73
15.1 to 25.0	5	197	246	394	591
	10	75	94	150	225
	15	41	51	82	122
	20	26	33	52	78
25.1 to 36.0	5	138	172	275	413
	10	53	66	106	159
	15	30	37	59	89
	20	19	24	38	58
36.1 to 46.0	5	129	161	257	386
	10	51	64	102	154
	15	29	36	58	87
	20	19	24	38	57
46.1 to 72.5	20	18	23	36	55
	30	10	13	20	30
	40	6	8	13	19
	50	4	6	9	13
72.6 to 121.0	20	10	12	20	30
	30	6	7	11	17
	40	4	5	7	11
	50	3	3	5	8
121.1 to 145.0	20	12	15	24	35
	30	7	9	15	22
	40	5	6	10	15
	50	4	5	8	11
145.1 to 169.0	20	12	15	24	36
	30	7	9	15	22
	40	5	7	10	16
	50	4	5	8	12
169.1 to 242.0	20	13	17	27	40
	30	8	10	17	25
	40	6	7	12	17
	50	4	5	9	13
242.1 to 362.0	20	25	32	51	76
	30	16	19	31	47
	40	11	14	22	33
	50	8	10	16	25
362.1 to 420.0	20	12	15	25	37
	30	8	10	15	23
	40	5	7	11	16
	50	4	5	8	12
420.1 to 550.0	20	23	29	47	70
	30	14	18	29	43
	40	10	13	20	30
	50	8	9	15	23
550.1 to 800.0	20	25	31	50	75
	30	15	19	31	46
	40	11	13	21	32
	50	8	10	16	24

Notes:

* This table is for open-air, phase-to-ground electric-arc exposures. It is not for phase-to-phase arcs or enclosed arcs (arc in a box).

† The table assumes the arc length to be the sparkover distance for the maximum phase-to-ground voltage of each voltage range (see Appendix B to Division 2/RR). The table also assumes that the employee will be the minimum approach distance minus twice the arc length from the electric arc.

‡ The Occupational Safety and Health Administration calculated the values in this table using the ARCPRO method listed in Table 2.

For voltages of more than 72.6 kV, employers may use this table only when the minimum approach distance established under 437-002-2311(3)(a) is greater than or equal to the following values:

72.6 to 121.0 kV 1.02 m.
121.1 to 145.0 kV 1.16 m.
145.1 to 169.0 kV 1.30 m.
169.1 to 242.0 kV 1.72 m.
242.1 to 362.0 kV 2.76 m.
362.1 to 420.0 kV 2.50 m.
420.1 to 550.0 kV 3.62 m.
550.1 to 800.0 kV 4.83 m.

** The voltage range is the phase-to-phase system voltage.

B. Selecting Protective Clothing and Other Protective Equipment

437-002-2311(8)(e) requires employers, in certain situations, to select protective clothing and other protective equipment with an arc rating that is greater than or equal to the incident heat energy estimated under 437-002-2311(8)(b). Based on laboratory testing required by ASTM F1506-10a, the expectation is that protective clothing with an arc rating equal to the estimated incident heat energy will be capable of preventing second-degree burn injury to an employee exposed to that incident heat energy from an electric arc. Note that actual electric-arc exposures may be more or less severe than the estimated value because of factors such as arc movement, arc length, arcing from reclosing of the system, secondary fires or explosions, and weather conditions. Additionally, for arc rating based on the fabric's arc thermal performance value 5 (ATPV), a worker exposed to incident energy at the arc rating has a 50-percent chance of just barely receiving a second-degree burn. Therefore, it is possible (although not likely) that an employee will sustain a second-degree (or worse) burn wearing clothing conforming to 437-002-2311(8)(e) under certain circumstances. However, reasonable employer estimates and maintaining appropriate minimum approach distances for employees should limit burns to relatively small burns that just barely extend beyond the epidermis (that is, just barely a second degree burn). Consequently, protective clothing and other protective equipment meeting 437-002-2311(8)(e) will provide an appropriate degree of protection for an employee exposed to electric-arc hazards.

437-002-2311(8)(e) does not require arc-rated protection for exposures of 2 cal/cm2 or less. Untreated cotton clothing will reduce a 2-cal/cm2 exposure below the 1.2- to 1.5-cal/cm2 level necessary to cause burn injury, and this material should not ignite at such low heat energy levels. Although 437-002-2311(8)(e) does not require clothing to have an arc rating when exposures are 2 cal/cm2 or less, 437-002-2311(8)(d) requires the outer layer of clothing to be flame resistant under certain conditions, even when the estimated incident heat energy is less than 2 cal/cm2, as discussed later in this appendix.

Additionally, it is especially important to ensure that employees do not wear undergarments made from fabrics listed in the note to 437-002-2311(8)(c) even when the outer layer is flame resistant or arc rated. These fabrics can melt or ignite easily when an electric arc occurs. Logos and name tags made from non-flame-resistant material can adversely affect the arc rating or the flame resistant characteristics of arc-rated or flame resistant clothing. Such logos and name tags may violate 437-002-2311(8)(c), (d), or (e).

437-002-2311(8)(e) requires that arc-rated protection cover the employee's entire body, with limited exceptions for the employee's hands, feet, face, and head. 437-002-2311(8)(e)(A) provides that arc-rated protection is not necessary for the employee's hands under the following conditions:

For any estimated incident heat energy	When the employee is wearing rubber insulating gloves with protectors.
If the estimated incident heat energy does not exceed 14 cal/cm^2	When the employee is wearing heavy-duty leather work gloves with a weight of at least 407 gm/m^2 (12 oz/yd^2).

437-002-2311(8)(e)(B) provides that arc-rated protection is not necessary for the employee's feet when the employee is wearing heavy-duty work shoes or boots. Finally, 437-002-2311(8)(e)(C), (D), and (E) require arc-rated head and face protection as follows:

Exposure	Minimum head and face protection		
	None *	Arc-rated faceshield with a minimum rating of 8 cal/cm^{2}*	Arc-rated hood or faceshield with balaclava
Single-phase, open air	2-8 cal/cm^2	9-12 cal/cm^2	13 cal/cm^2 or higher †.
Three-phase	2-4 cal/cm^2	5-8 cal/cm^2	9 cal/cm^2 or higher ‡.

* These ranges assume that employees are wearing hardhats meeting the specifications in 437-002-0134 or 437-003-0134, as applicable.
† The arc rating must be a minimum of 4 cal/cm2 less than the estimated incident energy. Note that 437-002-2311(8)(e)(E) permits this type of head and face protection, with a minimum arc rating of 4 cal/cm2 less than the estimated incident energy, at any incident energy level.
‡ Note that 437-002-2311(8)(e) permits this type of head and face protection at any incident energy level.

IV. Protection Against Ignition

437-002-2311(8)(c) prohibits clothing that could melt onto an employee's skin or that could ignite and continue to burn when exposed to flames or to the available heat energy estimated by the employer under 437-002-2311(8)(b). Meltable fabrics, such as acetate, nylon, polyester, and polypropylene, even in blends, must be avoided. When these fibers melt, they can adhere to the skin, thereby transferring heat rapidly, exacerbating burns, and complicating treatment. These outcomes can result even if the meltable fabric is not directly next to the skin. The remainder of this section focuses on the prevention of ignition.

437-002-2311(8)(e) generally requires protective clothing and other protective equipment with an arc rating greater than or equal to the employer's estimate of available heat energy. As explained earlier in this appendix, untreated cotton is usually acceptable for exposures of 2 cal/cm2 or less.6 If the exposure is greater than that, the employee generally must wear flame-resistant clothing with a suitable arc rating in accordance with 437-002-2311(8)(d) and (e). However, even if an employee is wearing a layer of flame-resistant clothing, there are circumstances under which flammable layers of clothing would be uncovered, and an electric arc could ignite them. For example, clothing ignition is possible if the employee is wearing flammable clothing under the flame-resistant clothing and the underlayer is uncovered because of an opening in the flame-resistant clothing. Thus, for purposes of 437-002-2311(8)(c), it is important for the employer to consider the possibility of clothing ignition even when an employee is wearing flame-resistant clothing with a suitable arc rating.

Under 437-002-2311(8)(c), employees may not wear flammable clothing in conjunction with flame-resistant clothing if the flammable clothing poses an ignition hazard.7 Although outer flame-resistant layers may not have openings that expose flammable inner layers, when an outer flame-resistant layer would be unable to resist breakopen,8 the next (inner) layer must be flame-resistant if it could ignite.

Non-flame-resistant clothing can ignite even when the heat energy from an electric arc is insufficient to ignite the clothing. For example, nearby flames can ignite an employee's clothing; and, even in the absence of flames, electric arcs pose ignition hazards beyond the hazard of ignition from incident energy under certain conditions. In addition to requiring flame-resistant clothing when the estimated incident energy exceeds 2.0 cal/cm2, 437-002-2311(8)(d) requires flame-resistant clothing when: The employee is exposed to contact with energized circuit parts operating at more than 600 volts (437-002-2311(8)(d)(A)), an electric arc could ignite flammable material in the work area that, in turn, could ignite the employee's clothing (437-002-2311(8)(d)(B)), and molten metal or electric arcs from faulted conductors in the work area could ignite the employee's clothing (437-002-2311(8)(d)(C)). For example, grounding conductors can become a source of heat energy if they cannot carry fault current without failure. The employer must consider these possible sources of electric arcs 9 in determining whether the employee's clothing could ignite under 437-002-2311(8)(d)(C).

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[1] Flame-resistant clothing includes clothing that is inherently flame resistant and clothing chemically treated with a flame retardant. (See ASTM F1506-10a, Standard Performance Specification for Flame Resistant Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards, and ASTM F1891-12 Standard Specification for Arc and Flame Resistant Rainwear.)

[2] The Occupational Safety and Health Administration used metric values to calculate the clearing times in Table 6 and Table 7. An employer may use English units to calculate clearing times instead even though the results will differ slightly.

[3] The Occupational Safety and Health Administration based this assumption, which is more conservative than the arc length specified in Table 5, on Table 410-2 of the 2012 NESC.

[4] The dielectric strength of air is about 10 kilovolts for every 25.4 millimeters (1 inch). Thus, the employer can estimate the arc length in millimeters to be the phase-to-ground voltage in kilovolts multiplied by 2.54 (or voltage (in kilovolts) × 2.54).

[5] ASTM F1506-10a defines "arc thermal performance value" as "the incident energy on a material or a multilayer system of materials that results in a 50% probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn injury based on the Stoll [footnote] curve, cal/cm2." The footnote to this definition reads: "Derived from: Stoll, A. M., and Chianta, M. A., 'Method and Rating System for

Evaluations of Thermal Protection,' Aerospace Medicine, Vol 40, 1969, pp. 1232-1238 and Stoll, A. M., and Chianta, M. A., 'Heat Transfer through Fabrics as Related to Thermal Injury,' Transactions-New York Academy of Sciences, Vol 33(7), Nov. 1971, pp. 649-670."

[6] See 437-002-2311(8)(d)(A), (B), and (C) for conditions under which employees must wear flame-resistant clothing as the outer layer of clothing even when the incident heat energy does not exceed 2 cal/cm2.

[7] 437-002-2311(8)(c) prohibits clothing that could ignite and continue to burn when exposed to the heat energy estimated under paragraph 437-002-2311(8)(b) of that section.

[8] Breakopen occurs when a hole, tear, or crack develops in the exposed fabric such that the fabric no longer effectively blocks incident heat energy.

[9] Static wires and pole grounds are examples of grounding conductors that might not be capable of carrying fault current without failure. Grounds that can carry the maximum available fault current are not a concern, and employers need not consider such grounds a possible electric arc source.

Appendix F to Division 2/RR - Work-Positioning Equipment Inspection Guidelines

I. Body Belts

Inspect body belts to ensure that:

A. The hardware has no cracks, nicks, distortion, or corrosion;
B. No loose or worn rivets are present;
C. The waist strap has no loose grommets;
D. The fastening straps are not 100-percent leather; and
E. No worn materials that could affect the safety of the user are present.

II. Positioning Straps

Inspect positioning straps to ensure that:

A. The warning center of the strap material is not exposed;
B. No cuts, burns, extra holes, or fraying of strap material is present;
C. Rivets are properly secured;
D. Straps are not 100-percent leather; and
E. Snaphooks do not have cracks, burns, or corrosion.

III. Climbers

Inspect pole and tree climbers to ensure that:

A. Gaffs are at least as long as the manufacturer's recommended minimums (generally 32 and 51 millimeters (1.25 and 2.0 inches) for pole and tree climbers, respectively, measured on the underside of the gaff);

Note: Gauges are available to assist in determining whether gaffs are long enough and shaped to easily penetrate poles or trees.

B. Gaffs and leg irons are not fractured or cracked;
C. Stirrups and leg irons are free of excessive wear;
D. Gaffs are not loose;
E. Gaffs are free of deformation that could adversely affect use;
F. Gaffs are properly sharpened; and
G. There are no broken straps or buckles.

Appendix G to Division 2/RR - Reference Documents

The references contained in this appendix provide information that can be helpful in understanding and complying with the requirements contained in Division 2/RR. The national consensus standards referenced in this appendix contain detailed specifications that employers may follow in complying with the more performance-based requirements of Division 2/RR. Except as specifically noted in Division 2/RR, however, the Occupational Safety and Health Administration will not necessarily deem compliance with the national consensus standards to be compliance with the provisions of Division 2/RR.

ANSI/SIA A92.2-2009,*American National Standard for Vehicle-Mounted Elevating and Rotating Aerial Devices.*

ANSI Z133-2012,*American National Standard Safety Requirements for Arboricultural Operations-Pruning, Trimming, Repairing, Maintaining, and Removing Trees, and Cutting Brush.*

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

ASME B20.1-2012,*Safety Standard for Conveyors and Related Equipment.*

ASTM D120-09,*Standard Specification for Rubber Insulating Gloves.*

ASTM D149-09 (2013),*Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.*

ASTM D178-01 (2010),*Standard Specification for Rubber Insulating Matting.*

ASTM D1048-12,*Standard Specification for Rubber Insulating Blankets.*

ASTM D1049-98 (2010),*Standard Specification for Rubber Insulating Covers.*

ASTM D1050-05 (2011),*Standard Specification for Rubber Insulating Line Hose.*

ASTM D1051-08,*Standard Specification for Rubber Insulating Sleeves.*

ASTM F478-09,*Standard Specification for In-Service Care of Insulating Line Hose and Covers.*

ASTM F479-06 (2011),*Standard Specification for In-Service Care of Insulating Blankets.*

ASTM F496-08,*Standard Specification for In-Service Care of Insulating Gloves and Sleeves.*

ASTM F711-02 (2007),*Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools.*

ASTM F712-06 (2011), *Standard Test Methods and Specifications for Electrically Insulating Plastic Guard Equipment for Protection of Workers.*

ASTM F819-10, *Standard Terminology Relating to Electrical Protective Equipment for Workers.*

ASTM F855-09, *Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment.*

ASTM F887-12$^{\varepsilon1}$, *Standard Specifications for Personal Climbing Equipment.*

ASTM F914/F914M-10, *Standard Test Method for Acoustic Emission for Aerial Personnel Devices Without Supplemental Load Handling Attachments.*

ASTM F1116-03 (2008), *Standard Test Method for Determining Dielectric Strength of Dielectric Footwear.*

ASTM F1117-03 (2008), *Standard Specification for Dielectric Footwear.*

ASTM F1236-96 (2012), *Standard Guide for Visual Inspection of Electrical Protective Rubber Products.*

ASTM F1430/F1430M-10, *Standard Test Method for Acoustic Emission Testing of Insulated and Non-Insulated Aerial Personnel Devices with Supplemental Load Handling Attachments.*

ASTM F1505-10, *Standard Specification for Insulated and Insulating Hand Tools.*

ASTM F1506-10a, *Standard Performance Specification for Flame Resistant and Arc Rated Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards.*

ASTM F1564-13, *Standard Specification for Structure-Mounted Insulating Work Platforms for Electrical Workers.*

ASTM F1701-12, *Standard Specification for Unused Polypropylene Rope with Special Electrical Properties.*

ASTM F1742-03 (2011), *Standard Specification for PVC Insulating Sheeting.*

ASTM F1796-09, *Standard Specification for High Voltage Detectors-Part 1 Capacitive Type to be Used for Voltages Exceeding 600 Volts AC.*

ASTM F1797-09$^{\varepsilon1}$, *Standard Test Method for Acoustic Emission Testing of Insulated and Non-Insulated Digger Derricks.*

ASTM F1825-03 (2007), *Standard Specification for Clampstick Type Live Line Tools.*

ASTM F1826-00 (2011), *Standard Specification for Live Line and Measuring Telescoping Tools.*

ASTM F1891-12, *Standard Specification for Arc and Flame Resistant Rainwear.*

ASTM F1958/F1958M-12, *Standard Test Method for Determining the Ignitability of Non-flame-Resistant Materials for Clothing by Electric Arc Exposure Method Using Mannequins.*

ASTM F1959/F1959M-12, *Standard Test Method for Determining the Arc Rating of Materials for Clothing.*

IEEE Stds 4-1995,4a-2001(Amendment to IEEE Standard Techniques for High-Voltage Testing), *IEEE Standard Techniques for High-Voltage Testing.*

IEEE Std 62-1995, *IEEE Guide for Diagnostic Field Testing of Electric Power Apparatus-Part 1: Oil Filled Power Transformers, Regulators, and Reactors.*

IEEE Std 80-2000, *Guide for Safety in AC Substation Grounding.*

IEEE Std 100-2000, *The Authoritative Dictionary of IEEE Standards Terms Seventh Edition.*

IEEE Std 516-2009, *IEEE Guide for Maintenance Methods on Energized Power Lines.*

IEEE Std 524-2003, *IEEE Guide to the Installation of Overhead Transmission Line Conductors .*

IEEE Std 957-2005, *IEEE Guide for Cleaning Insulators.*

IEEE Std 1048-2003, *IEEE Guide for Protective Grounding of Power Lines.*

IEEE Std 1067-2005, *IEEE Guide for In-Service Use, Care, Maintenance, and Testing of Conductive Clothing for Use on Voltages up to 765 kV AC and ±750 kV DC.*

IEEE Std 1307-2004, *IEEE Standard for Fall Protection for Utility Work.*

IEEE Stds 1584-2002,1584a-2004 Amendment 1 to IEEE Std 1584-2002), and 1584b-2011 (Amendment 2: Changes to Clause 4 of IEEE Std 1584-2002), *IEEE Guide for Performing Arc-Flash Hazard Calculations.*

IEEE C2-2012, *National Electrical Safety Code.*

NFPA 70E-2012, *Standard for Electrical Safety in the Workplace.*