MIOSHA-STD-1312 (02/16)
88 Pages

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DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS

DIRECTOR'S OFFICE

CONSTRUCTION SAFETY STANDARDS

Filed with the Secretary of State on March 19, 1982 (as amended May 29, 1985) (as amended September 3, 1996) (as amended August 22, 2005) (as amended November 24, 2010) (as amended January 9, 2013) (as amended May 21, 2015) **(as amended February 24, 2016)**

These rules become effective immediately upon filing with the Secretary of State unless adopted under section 33, 44, or 45a(6) of 1969 PA 306.

Rules adopted under these sections become effective 7 days after filing with the Secretary of State.

(By authority conferred on the director of the department of licensing and regulatory affairs by sections 19 and 21 of 1974 PA 154, MCL 408.1019 and 408.1021 and Executive Reorganization Order Nos. 1996-2, 2003-1, 2008-4, and 2011-4, MCL 445.2001, 445.2011, 445.2025, and 445.2030)

R 408.41605 and R 408.41610 of the Administrative Code are amended, as follows:

CONSTRUCTION SAFETY AND HEALTH STANDARD PART 16. POWER TRANSMISSION AND DISTRIBUTION

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R 408.41601 Application.

Rule 1601. (1) The occupational safety and health standards contained in this part apply to the construction of electric transmission and distribution lines and equipment.

(2) As used in this part, 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.

(3) Existing electric transmission and distribution lines and electrical equipment need not be modified to conform to the requirements of applicable standards in this part until such work as described in subrule (2) of this rule is to be performed on such lines or equipment.

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

(5) This standard does not apply to communication lines defined as the conductors and their supporting or containing structures that are used for public or private signal or communication service, that operate at potentials not exceeding 400 volts to ground or 750 volts between any 2 points of the circuit, and the transmitted power of which does not exceed 150 watts. When operating at less than 150 volts, no limit is placed on the capacity of the system. Telephone, telegraph, railroad signal, data, clock, fire, police-alarm, community television antenna, and other systems conforming with this subrule are examples of communication lines. Lines used for signaling purposes, but not included in this definition, are considered as supply lines of the same voltage and are to be so run.

R 408.41605 Adoption of OSHA rules.

Rule 1605. (1) The following provisions of the occupational safety and health administration, (OSHA) regulations, except as amended in these rules, are adopted by reference in these rules:

(a) 29 C.F.R. §1926.950 “General.”

(b) 29 C.F.R. §1926.951 “Medical services and first aid.”

(c) 29 C.F.R. §1926.952 “Job briefing.”

(d) 29 C.F.R. §1926.953 “Enclosed spaces.”

(e) 29 C.F.R. §1926.954 “Personal protective equipment.”

(f) 29 C.F.R. §1926.955 “Portable ladders and platforms.”

(g) 29 C.F.R. §1926.956 “Hand and portable power equipment.”

(h) 29 C.F.R. §1926.957 “Live-line tools.”

(i) 29 C.F.R. §1926.958 “Materials handling and storage.”

(j) 29 C.F.R. §1926.959 “Mechanical equipment.”

(k) 29 C.F.R. §1926.960 “Working on or near exposed energized parts.”

(l) 29 C.F.R. §1926.961 “Deenergizing lines and equipment for employee protection.”

(m) 29 C.F.R. §1926.962 “Grounding for the protection of employees.”

(n) 29 C.F.R. §1926.963 “Testing and test facilities.”

(o) 29 C.F.R. §1926.964 “Overhead lines and live-line barehand work.”

(p) 29 C.F.R. §1926.965 “Underground electrical installations.”

(q) 29 C.F.R. §1926.966 “Substations.”

(r) 29 C.F.R. §1926.967 “Special conditions.”

(s) 29 C.F.R. §1926.968 “Definitions.”

(t) Appendix A to Subpart V of Part 1926 “Reserved.”

(u) Appendix B to Subpart V of Part 1926 “Working on Exposed Energized Parts.”

(v) Appendix C to Subpart V of Part 1926 “Protection from Hazardous Differences in Electric Potential.”

(w) Appendix D to Subpart V of Part 1926 “Methods of Inspecting and Testing Wood Poles.”

(x) Appendix E to Subpart V of Part 1926 “Protection from Flames and Electric Arcs.”

(y) Appendix F to Subpart V of Part 1926 “Work-Positioning Equipment Inspection Guidelines.”

(z) Appendix G to Subpart V of Part 1926 “Reference Documents.”

(2) All of the following provisions apply with respect to the regulations adopted in subrule (1) of this rule and are referenced in R 408.41610:

(a) A reference to 29 C.F.R. §1926.50 “Medical services and first aid,” means Construction Safety Standard (CS) Part 1 “General Rules.”

(b) A reference to 29 C.F.R. §1926.54 “Nonionizing radiation,” means Occupational Health Standard (OH) Part 681 “Radiation of Construction: Ionizing and Nonionizing.”

(c) A reference to 29 C.F.R. §1926.56 “Illumination,” means CS Part 1 “General Rules.”

(d) A reference to 29 C.F.R. §1926.59 “Hazard Communication,” means CS Part 42 “Hazard Communication.”

(e) A reference to 29 C.F.R. §1926.95 “Criteria for personal protective equipment,” means CS Part 6 “Personal Protective Equipment.”

(f) A reference to 29 C.F.R. §1926.100 “Head protection,” means CS Part 6 “Personal Protective Equipment.”

(g) A reference to 29 C.F.R. §1926.106 “Working over or near water,” means CS Part 6 “Personal Protective Equipment.”

(h) A reference to 29 C.F.R. §1926.200 “Accident prevention signs and tags,” means CS Part 22 “Signals, Signs, Tags, and Barricades.”

(i) A reference to 29 C.F.R. §1926.302 “Power-operated hand tools,” means CS Part 19 “Tools.”

(j) A reference to 29 C.F.R. §1926.453 “Aerial lifts,” means CS Part 32 “Aerial Work Platforms.”

(k) A reference to 29 C.F.R. §1926.502 “Fall protection systems criteria and practices,” means CS Part 45 “Fall Protection.”

(l) A reference to 29 C.F.R. §1926.1053 “Ladders,” means CS Part 11 “Fixed and Portable Ladders.”

(m) A reference to 29 C.F.R. §1926.1204 “Permit-required confined space program” through §1926.1211 “Rescue and emergency services,” means CS Part 35 “Confined Space in Construction.”

(n) A reference to “subpart AA of this part,” means CS Part 35 “Confined Space in Construction.”

(o) A reference to 29 C.F.R. §1910.97 “Nonionizing radiation,” means OH Part 382 “Nonionizing Radiation.”

(p) A reference to 29 C.F.R. §1910.135 “Head protection,” means General Industry Safety Standard (GI) Part 33 “Personal Protective Equipment.”

(q) A reference to 29 C.F.R. §1910.268 “Telecommunications,” means CS Part 30 “Telecommunications,” and GI Part 50 “Telecommunications.”

(r) A reference to 29 C.F.R. §1910.269 “Electric Power Generation, Transmission, and Distribution,” means GI Part 86 “Electric Power Generation, Transmission, and Distribution.”

(s) A reference to 29 C.F.R. §1910.1200 “Hazard Communication,” means GI Part 92 “Hazard Communication,” and OH Part 430 “Hazard Communication.”

(3) The provisions of the OSHA regulations adopted in these rules have the same force and effect as rules promulgated under Michigan occupational safety and health act, 1974 PA 154, MCL 408.1001 to 408.1094.

R 408.41610 Adopted and referenced standards.

Rule 1610. (1) The following federal occupational safety and health administration (OSHA) regulations, amended July 10, 2014, except as noted, are adopted by reference in these rules:

(a) 29 C.F.R. §1926.950 "General."

(b) 29 C.F.R. §1926.951 "Medical services and first aid."

(c) 29 C.F.R. §1926.952 "Job briefing."

(d) 29 C.F.R. §1926.953 "Enclosed spaces," amended May 4, 2015.

(e) 29 C.F.R. §1926.954 "Personal protective equipment."

(f) 29 C.F.R. §1926.955 "Portable ladders and platforms."

(g) 29 C.F.R. §1926.956 "Hand and portable power equipment."

(h) 29 C.F.R. §1926.957 "Live-line tools."

(i) 29 C.F.R. §1926.958 "Materials handling and storage."

(j) 29 C.F.R. §1926.959 "Mechanical equipment."

(k) 29 C.F.R. §1926.960 "Working on or near exposed energized parts," amended September 24, 2014.

(l) 29 C.F.R. §1926.961 "Deenergizing lines and equipment for employee protection."

(m) 29 C.F.R. §1926.962 "Grounding for the protection of employees."

(n) 29 C.F.R. §1926.963 "Testing and test facilities."

(o) 29 C.F.R. §1926.964 "Overhead lines and live-line barehand work."

(p) 29 C.F.R. §1926.965 "Underground electrical installations."

(q) 29 C.F.R. §1926.966 "Substations."

(r) 29 C.F.R. §1926.967 "Special conditions."

(s) 29 C.F.R. §1926.968 "Definitions," amended May 4, 2015.

(t) Appendix A to Subpart V of Part 1926 "Reserved."

(u) Appendix B to Subpart V of Part 1926 "Working on Exposed Energized Parts," amended September 24, 2014.

(v) Appendix C to Subpart V of Part 1926 "Protection from Hazardous Differences in Electric Potential."

(w) Appendix D to Subpart V of Part 1926 "Methods of Inspecting and Testing Wood Poles."

(x) Appendix E to Subpart V of Part 1926 "Protection from Flames and Electric Arcs."

(y) Appendix F to Subpart V of Part 1926 "Work-Positioning Equipment Inspection Guidelines."

(z) Appendix G to Subpart V of Part 1926 "Reference Documents."

(2) The standards adopted in these rules are available from the United States Department of Labor, Occupational Safety and Health Administration website: www.osha.gov, at no charge as of the time of adoption of these rules.

(3) The standards adopted in these rules are available for inspection at the Department of Licensing and Regulatory Affairs, MIOSHA Regulatory Services Section, 530 West Allegan Street, P.O. Box 30643, Lansing, Michigan, 48909-8143.

(4) The standards adopted in these rules may be obtained from the publisher or may be obtained from the Department of Licensing and Regulatory Affairs, MIOSHA Regulatory Services Section, 530 West Allegan Street, P.O. Box 30643, Lansing, Michigan, 48909-8143, plus $20.00 for shipping and handling.

(5) The following Michigan Occupational Safety and Health (MIOSHA) standards are referenced in these rules. Up to 5 copies of these standards may be obtained at no charge from the Michigan Department of Licensing and Regulatory Affairs, MIOSHA Regulatory Services Section, 530 West Allegan Street, P.O. Box 30643, Lansing, Michigan, 48909-8143 or via the internet at website: www.michigan.gov/mioshastandards. For quantities greater than 5, the cost, as of the time of adoption of these rules, is 4 cents per page.

(a) Construction Safety Standard Part 1 "General Rules," R 408.40101 to R 408.40134.

(b) Construction Safety Standard Part 6 "Personal Protective Equipment," R 408.40601 to R 408.40641.

(c) Construction Safety Standard Part 11 "Fixed and Portable Ladders," R 408.41101 to R 408.41140

(d) Construction Safety Standard Part 19 "Tools," R 408.41901 to R 408.41980.

(e) Construction Safety Standard Part 22 "Signals, Signs, Tags, and Barricades," R 408.42201 to R 408.42243.

(f) Construction Safety Standard Part 30 "Telecommunications," R 408.43001 to R 408.43006.

(g) Construction Safety Standard Part 32 "Aerial Work Platforms," R 408.43201 to R 408.43220.

(h) Construction Safety Standard Part 35 "Confined Space in Construction," R 408.43501 to R 408.43510.

(i) Construction Safety Standard Part 42 "Hazard Communication," R 408.44201 to R 408.44204.

(j) Construction Safety Standard Part 45 "Fall Protection," R 408.44501 to R 408.44502

(k) General Industry Safety Standard Part 33 "Personal Protective Equipment," R 408.13301 to R 408.13398.

(l) General Industry Safety Standard Part 50 "Telecommunications," R 408.15001 to R 408.15004.

(m) General Industry Safety Standard Part 86 "Electric Power Generation, Transmission, and Distribution," R 408.18601 to R 408.18602.

(n) General Industry Safety Standard Part 92 "Hazard Communication," R 408.19201 to R 408.19204.

(o) Occupational Health Standard Part 382 "Nonionizing Radiation," R 325.60701 to R 325.60704.

(p) Occupational Health Standard Part 430 “Hazard Communication,” R 325.77001 to R 325.77004.

(q) Occupational Health Standard Part 681 “Radiation of Construction: Ionizing and Nonionizing,” R 325.68101 to R 325.68102.

ELECTRIC POWER GENERATION, TRANSMISSION, AND DISTRIBUTION

Table of Contents:

1926.950 GENERAL

1926.950(a) Application.
1926.950(a)(1) Scope.
1926.950(a)(1)(i) This subpart, except for paragraph (a)(3) of this section, covers the construction of electric power transmission and distribution lines and equipment. As used in this subpart, 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.
Note to paragraph (a)(1)(i): An employer that complies with §1910.269 of this chapter will be considered in compliance with requirements in this subpart that do not reference other subparts of this part. Compliance with §1910.269 of this chapter will not excuse an employer from compliance obligations under other subparts of this part.
1926.950(a)(1)(ii) Notwithstanding paragraph (a)(1)(i) of this section, this subpart does not apply to electrical safety-related work practices for unqualified employees.
1926.950(a)(2) Other Part 1926 standards. This subpart applies in addition to all other applicable standards contained in this Part 1926. Employers covered under this subpart are not exempt from complying with other applicable provisions in Part 1926 by the operation of §1910.5(c) of this chapter. Specific references in this subpart to other sections of Part 1926 are provided for emphasis only.
1926.950(a)(3) Applicable Part 1910 requirements. Line-clearance tree trimming operations and work involving electric power generation installations shall comply with §1910.269 of this chapter.

1926.950(b) Training.
1926.950(b)(1) All employees.
1926.950(b)(1)(i) Each employee shall be trained in, and familiar with, the safety-related work practices, safety procedures, and other safety requirements in this subpart that pertain to his or her job assignments.
1926.950(b)(1)(ii) Each employee shall also be trained in and familiar with any other safety practices, including applicable emergency procedures (such as pole-top and manhole rescue), that are not specifically addressed by this subpart but that are related to his or her work and are necessary for his or her safety.
1926.950(b)(1)(iii) The degree of training shall be determined by the risk to the employee for the hazard involved.

1926.950(b)(2) Qualified employees. Each qualified employee shall also be trained and competent in:
1926.950(b)(2)(i) The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment,
1926.950(b)(2)(ii) The skills and techniques necessary to determine the nominal voltage of exposed live parts,
1926.950(b)(2)(iii) The minimum approach distances specified in this subpart corresponding to the voltages to which the qualified employee will be exposed and the skills and techniques necessary to maintain those distances,
1926.950(b)(2)(iv) 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
1926.950(b)(2)(v) 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 (b)(2): For the purposes of this subpart, a person must have the training required by paragraph (b)(2) of this section to be considered a qualified person.
1926.950(b)(3) Supervision and annual inspection. The employer shall determine, through regular supervision and through inspections conducted on at least an annual basis,that each employee is complying with the safety related work practices required by this subpart.
1926.950(b)(4) Additional training. An employee shall receive additional training (or retraining) under any of the following conditions:
1926.950(b)(4)(i) If the supervision or annual inspections required by paragraph (b)(3) of this section indicate that the employee is not complying with the safety-related work practices required by this subpart, or
1926.950(b)(4)(ii) 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
1926.950(b)(4)(iii) If he or she must employ safety related work practices that are not normally used during his or her regular job duties.
Note to paragraph (b)(4)(iii): The Occupational Safety and Health Administration considers tasks that are performed less often than once per year to necessitate retraining before the performance of the work practices involved.
1926.950(b)(5) Type of training. The training required by paragraph (b) of this section shall be of the classroom or on-the-job type.
1926.950(b)(6) Training goals. The training shall establish employee proficiency in the work practices required by this subpart and shall introduce the procedures necessary for compliance with this subpart.
1926.950(b)(7) Demonstration of proficiency**.** The employer shall 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 (b) of this section.
Note 1 to paragraph (b)(7): 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 (b)(7): 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 (b) of this section, (2) use an examination or interview to make an initial determination that the employee understands the relevant safety related work practices before he or she performs any work covered by this subpart, and (3) supervise the employee closely until that employee has demonstrated proficiency as required by this paragraph.

1926.950(c) Information transfer.
1926.950(c)(1) Host employer responsibilities. Before work begins, the host employer shall inform contract employers of:
1926.950(c)(1)(i) 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 (d)(1) through (d)(5) of this section;
Note to paragraph (c)(1)(i): This paragraph requires the host employer to obtain information listed in paragraphs (d)(1) through (d)(5) of this section if it does not have this information in existing records.

1926.950(c)(1)(ii) Conditions that are related to the safety of the work to be performed, that are listed in paragraphs (d)(6) through (d)(8) of this section, and that are known to the host employer;
Note to paragraph (c)(1)(ii): 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.
1926.950(c)(1)(iii) Information about the design and operation of the host employer's installation that the contract employer needs to make the assessments required by this subpart; and
Note to paragraph (c)(1)(iii): 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.

1926.950(c)(1)(iv) 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 (c)(1)(iv): 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.

1926.950(c)(2) Contract employer responsibilities.

1926.950(c)(2)(i) The contract employer shall 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 (c)(1) of this section.

1926.950(c)(2)(ii) Before work begins, the contract employer shall advise the host employer of any unique hazardous conditions presented by the contract employer's work

1926.950(c)(2)(iii) The contract employer shall 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 (c)(1) of this section. The contract employer shall provide this information to the host employer within 2 working days after discovering the hazardous condition.

1926.950(c)(3) Joint host- and contract-employer responsibilities. The contract employer and the host employer shall coordinate their work rules and procedures so that each employee of the contract employer and the host employer is protected as required by this subpart.

1926.950(d) 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 shall be determined before work on or near the lines or equipment is started. Such characteristics and conditions include, but are not limited to:

1926.950(d)(1) The nominal voltages of lines and equipment,

1926.950(d)(2) The maximum switching-transient voltages,

1926.950(d)(3) The presence of hazardous induced voltages,

1926.950(d)(4) The presence of protective grounds and equipment grounding conductors,

1926.950(d)(5) The locations of circuits and equipment, including electric supply lines, communication lines, and fire protective signaling circuits,

1926.950(d)(6) The condition of protective grounds and equipment grounding conductors,

1926.950(d)(7) The condition of poles, and

1926.950(d)(8) Environmental conditions relating to safety.

[Filed April 1, 2014] [79 FR 20696-20697, July 10, 2014]

1926.951 MEDICAL SERVICES AND FIRST AID

1926.951(a) General. The employer shall provide medical services and first aid as required in §1926.50.

1926.951(b) First-aid training. In addition to the requirements of §1926.50, when employees are performing work on, or associated with, exposed lines or equipment energized at 50 volts or more, persons with first-aid training shall be available as follows:

1926.951(b)(1) Field work. For field work involving two or more employees at a work location, at least two trained persons shall be available.

1926.951(b)(2) Fixed work locations. For fixed work locations such as substations, the number of trained persons available shall be sufficient to ensure that each employee exposed to electric shock can be reached within 4 minutes by a trained person. However, where the existing number of employees is insufficient to meet this requirement (at a remote substation, for example), each employee at the work location shall be a trained employee.

[59 FR 40730, Aug. 9, 1994; 79 FR 20698, July 10, 2014]

1926.952 JOB BRIEFING

1926.952(a) Before each job.
1926.952(a)(1) Information provided by the employer. In assigning an employee or a group of employees to perform a job, the employer shall provide the employee in charge of the job with all available information that relates to the determination of existing characteristics and conditions required by §1926.950(d).
1926.952(a)(2) Briefing by the employee in charge. The employer shall ensure that the employee in charge conducts a job briefing that meets paragraphs (b), (c), and (d) of this section with the employees involved before they start each job.

1926.952(b) Subjects to be covered. The briefing shall cover at least the following subjects: Hazards associated with the job, work procedures involved, special precautions, energy-source controls, and personal protective equipment requirements.

1926.952(c) Number of briefings.
1926.952(c)(1) At least one before each day or shift. If the work or operations to be performed during the work day or shift are repetitive and similar, at least one job briefing shall be conducted before the start of the first job of each day or shift.
1926.952(c)(2) Additional briefings. Additional job briefings shall be held if significant changes, which might affect the safety of the employees, occur during the course of the work.

1926.952(d) Extent of briefing.
1926.952(d)(1) Short discussion. 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.
1926.952(d)(2) Detailed discussion. A more extensive discussion shall be conducted:
1926.952(d)(2)(i) If the work is complicated or particularly hazardous, or
1926.952(d)(2)(ii) If the employee cannot be expected to recognize and avoid the hazards involved in the job.
Note to paragraph (d): The briefing must address all the subjects listed in paragraph (b) of this section.

1926.952(e) Working alone. An employee working alone need not conduct a job briefing. However, the employer shall ensure that the tasks to be performed are planned as if a briefing were required.

[75 FR 48135, Aug. 9, 2010; 78 FR 32116, May 29, 2013; 79 FR 20698, July 10, 2014]

1926.953 ENCLOSED SPACES

1926.953(a) General. This section covers enclosed spaces that may be entered by employees. It does not apply to vented vaults if the employer makes a determination that the ventilation system is operating to protect employees before they enter the space. This section applies to routine entry into enclosed spaces. If, after the employer takes the precautions given in this section and in §1926.965, 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 subpart AA of this part. For routine entries where the hazards remaining in the enclosed space do not endanger the life of an entrant or interfere with an entrant's escape from the space, this section applies in lieu of the permit space entry requirements contained in §§1926.1204 through 926.1211.

1926.953(b) Safe work practices. The employer shall ensure the use of safe work practices for entry into, and work in, enclosed spaces and for rescue of employees from such spaces.

1926.953(c) Training. Each employee who enters an enclosed space or who serves as an attendant shall be trained in the hazards of enclosed-space entry, in enclosed-space entry procedures, and in enclosed-space rescue procedures.

1926.953(d) Rescue equipment. Employers shall provide equipment to ensure the prompt and safe rescue of employees from the enclosed space.

1926.953(e) Evaluating potential hazards. Before any entrance cover to an enclosed space is removed, the employer shall determine whether it is safe to do so by checking for the presence of any atmospheric pressure or temperature differences and by evaluating whether there might be a hazardous atmosphere in the space. Any conditions making it unsafe to remove the cover shall be eliminated before the cover is removed.
Note to paragraph (e): 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.

1926.953(f) Removing covers. When covers are removed from enclosed spaces, the opening shall be promptly guarded by a railing, temporary cover, or other barrier designed to prevent an accidental fall through the opening and to protect employees working in the space from objects entering the space.

1926.953(g) Hazardous atmosphere. Employees may not enter any enclosed space while it contains a hazardous atmosphere, unless the entry conforms to the confined spaces in construction standard in subpart AA of this part.

1926.953(h) Attendants. While work is being performed in the enclosed space, an attendant with first-aid training shall be immediately available outside the enclosed space to provide assistance if a hazard exists because of traffic patterns in the area of the opening used for entry. The attendant is not precluded from performing other duties outside the enclosed space if these duties do not distract the attendant from: Monitoring employees within the space or ensuring that it is safe for employees to enter and exit the space.
Note to paragraph (h): See §1926.965 for additional requirements on attendants for work in manholes and vaults.

1926.953(i) Calibration of test instruments. Test instruments used to monitor atmospheres in enclosed spaces shall be kept in calibration and shall have a minimum accuracy of ±10 percent.

1926.953(j) Testing for oxygen deficiency. Before an employee enters an enclosed space, the atmosphere in the enclosed space shall be tested for oxygen deficiency with a direct-reading meter or similar instrument, capable of collection and immediate analysis of data samples without the need for 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.

1926.953(k) Testing for flammable gases and vapors. Before an employee enters an enclosed space, the internal atmosphere shall be tested for flammable gases and vapors with a direct-reading meter or similar instrument capable of collection and immediate analysis of data samples without the need for off-site evaluation. This test shall be performed after the oxygen testing and ventilation required by paragraph (j) of this section demonstrate that there is sufficient oxygen to ensure the accuracy of the test for flammability.

1926.953(l) 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 shall be used to maintain oxygen at a safe level and to prevent a hazardous concentration of flammable gases and vapors from accumulating. A continuous monitoring program to ensure that no increase in flammable gas or vapor concentration 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 (l): See the definition of "hazardous atmosphere" for guidance in determining whether a specific concentration of a substance is hazardous.

1926.953(m) Specific ventilation requirements. If continuous forced-air ventilation is used, it shall begin before entry is made and shall be maintained long enough for the employer to be able to demonstrate that a safe atmosphere exists before employees are allowed to enter the work area. The forced-air ventilation shall be so directed as to ventilate the immediate area where employees are present within the enclosed space and shall continue until all employees leave the enclosed space.

1926.953(n) Air supply. The air supply for the continuous forced-air ventilation shall be from a clean source and may not increase the hazards in the enclosed space.

1926.953(o) Open flames. If open flames are used in enclosed spaces, a test for flammable gases and vapors shall be made immediately before the open flame device is used and at least once per hour while the device is used in the space. Testing shall be conducted more frequently if conditions present in the enclosed space indicate that once per hour is insufficient to detect hazardous accumulations of flammable gases or vapors.
Note to paragraph (o): See the definition of "hazardous atmosphere" for guidance in determining whether a specific concentration of a substance is hazardous.
Note to §1926.953: Entries into enclosed spaces conducted in accordance with the permit space entry requirements of subpart AA of this part are considered as complying with this section.

[75 FR 48135, Aug. 9, 2010; 78 FR 32116, May 29, 2013; 79 FR 20698-20699, July 10, 2014; 80 FR 25518, May 4, 2015]

1926.954 PERSONAL PROTECTIVE EQUIPMENT

1926.954(a) General. Personal protective equipment shall meet the requirements of Subpart E of this part.
Note to paragraph (a): Paragraph (d) of §1926.95 sets employer payment obligations for the personal protective equipment required by this subpart, including, but not limited to, the fall protection equipment required by paragraph (b) of this section, the electrical protective equipment required by §1926.960(c), and the flame-resistant and arc-rated clothing and other protective equipment required by §1926.960(g).

1926.954(b) Fall protection.
1926.954(b)(1) Personal fall arrest systems.
1926.954(b)(1)(i) Personal fall arrest systems shall meet the requirements of Subpart M of this part.
1926.954(b)(1)(ii) Personal fall arrest equipment used by employees who are exposed to hazards from flames or electric arcs, as determined by the employer under §1926.960(g)(1), shall be capable of passing a drop test equivalent to that required by paragraph (b)(2)(xii) of this section after exposure to an electric arc with a heat energy of 40±5 cal/cm^2.

1926.954(b)(2) Work-positioning equipment. Body belts and positioning straps for Work-positioning equipment shall meet the following requirements:
1926.954(b)(2)(i) Hardware for body belts and positioning straps shall meet the following requirements:
1926.954(b)(2)(i)(A) Hardware shall be made of dropforged steel, pressed steel, formed steel, or equivalent material.
1926.954(b)(2)(i)(B) Hardware shall have a corrosion-resistant finish.
1926.954(b)(2)(i)(C) Hardware surfaces shall be smooth and free of sharp edges.
1926.954(b)(2)(ii) Buckles shall 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).
1926.954(b)(2)(iii) D rings shall be capable of withstanding a 22-kilonewton (5,000-pound-force) tensile test without cracking or breaking.

1926.954(b)(2)(iv) Snaphooks shall be capable of withstanding a 22-kilonewton (5,000-pound-force) tension test without failure.
Note to paragraph (b)(2)(iv): Distortion of the snaphook sufficient to release the keeper is considered to be tensile failure of a snaphook.
1926.954(b)(2)(v) 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.
1926.954(b)(2)(vi) Plied fabric used in positioning straps and in load-bearing parts of body belts shall be constructed in such a way that no raw edges are exposed and the plies do not separate.
1926.954(b)(2)(vii) Positioning straps shall be capable of withstanding the following tests:
1926.954(b)(2)(vii)(A) A dielectric test of 819.7 volts, AC, per centimeter (25,000 volts per foot) for 3 minutes without visible deterioration;
1926.954(b)(2)(vii)(B) 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 (b)(2)(vii)(A) and (b)(2)(vii)(B): Positioning straps that pass direct-current tests at equivalent voltages are considered as meeting this requirement.
1926.954(b)(2)(vii)(C) Tension tests of 20 kilo newtons (4,500 pounds-force) for sections free of buckle holes and of 15 kilo newtons (3,500 pounds-force) for sections with buckle holes;
1926.954(b)(2)(vii)(D) A buckle-tear test with a load of 4.4 kilo newtons (1,000 pounds-force); and
1926.954(b)(2)(vii)(E) A flammability test in accordance with Table V-1.

TABLE V-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.	Any flames on the positioning strap shall self-extinguish.
Use a butane or propane burner with a 76-mm (3-inch) flame	The positioning strap shall continue to support the 100-kg (220.5-lb) mass.
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.	

1926.954(b)(2)(viii) The cushion part of the body belt shall contain no exposed rivets on the inside and shall be at least 76 millimeters (3 inches) in width.
1926.954(b)(2)(ix) Tool loops shall 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.
1926.954(b)(2)(x) Copper, steel, or equivalent liners shall be used around the bars of D rings to prevent wear between these members and the leather or fabric enclosing them.
1926.954(b)(2)(xi) Snaphooks shall be of the locking type meeting the following requirements:
1926.954(b)(2)(xi)(A) The locking mechanism shall first be released, or a destructive force shall be placed on the keeper, before the keeper will open.
1926.954(b)(2)(xi)(B) A force in the range of 6.7 N (1.5 lbf) to 17.8 N (4 lbf) shall be required to release the locking mechanism.
1926.954(b)(2)(xi)(C) 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 shall begin to open with a maximum force of 17.8 N (4 lbf).

1926.954(b)(2)(xii) Body belts and positioning straps shall be capable of withstanding a drop test as follows:
1926.954(b)(2)(xii)(A) The test mass shall 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 shall be increased proportionately (that is, the test mass must equal the mass of the equipped worker divided by 1.4).
1926.954(b)(2)(xii)(B) For body belts, the body belt shall be fitted snugly around the test mass and shall be attached to the test-structure anchorage point by means of a wire rope.
1926.954(b)(2)(xii)(C) For positioning straps, the strap shall 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.
1926.954(b)(2)(xii)(D) The test mass shall be dropped an unobstructed distance of 1 meter (39.4 inches) from a supporting structure that will sustain minimal deflection during the test.
1926.954(b)(2)(xii)(E) Body belts shall successfully arrest the fall of the test mass and shall be capable of supporting the mass after the test.
1926.954(b)(2)(xii)(F) Positioning straps shall successfully arrest the fall of the test mass without breaking, and the arrest force may not exceed 17.8 kilo newtons (4,000 pounds-force). Additionally, snaphooks on positioning straps may not distort to such an extent that the keeper would release.
Note to paragraph (b)(2): 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 F887-12^{e1}, are deemed to be in compliance with paragraph (b)(2) of this section.

1926.954(b)(3) Care and use of personal fall protection equipment.
1926.954(b)(3)(i) Work-positioning equipment shall 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 (b)(3)(i): Appendix F to this subpart contains guidelines for inspecting work-positioning equipment.
1926.954(b)(3)(ii) Personal fall arrest systems shall be used in accordance with §1926.502(d).
Note to paragraph (b)(3)(ii): 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.
1926.954(b)(3)(iii) The employer shall ensure that employees use fall protection systems as follows:
1926.954(b)(3)(iii)(A) Each employee working from an aerial lift shall use a fall restraint system or a personal fall arrest system. Paragraph (b)(2)(v) of §1926.453 does not apply.
1926.954(b)(3)(iii)(B) Except as provided in paragraph (b)(3)(iii)(C) of this section, each employee in elevated locations more than 1.2 meters (4 feet) above the ground on poles, towers, or similar structures shall 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 Subpart M of this part.
1926.954(b)(3)(iii)(C) Until March 31, 2015, a qualified employee climbing or changing location on poles, towers, or similar structures need not use fall protection equipment, unless conditions, such as, but not limited to, ice, high winds, the design of the structure (for example, no provision for holding on with hands), or the presence of contaminants on the structure, could cause the employee to lose his or her grip or footing. On and after April 1, 2015, each qualified employee climbing or changing location on poles, towers, or similar structures 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 (b)(3)(iii)(B) and (b)(3)(iii)(C): 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. Subpart M of this part contains the duty to provide fall protection associated with walking and working surfaces.
Note 2 to paragraphs (b)(3)(iii)(B) and (b)(3)(iii)(C): Until the employer ensures that employees are proficient in climbing and the use of fall protection under Â §1926.950(b)(7), the employees are not considered "qualified employees" for the purposes of paragraphs (b)(3)(iii)(B) and (b)(3)(iii)(C) of this section. These paragraphs require unqualified employees (including trainees) to use fall protection any time they are more than 1.2 meters (4 feet) above the ground.
1926.954(b)(3)(iv) On and after April 1, 2015, Work-positioning systems shall be rigged so that an employee can free fall no more than 0.6 meters (2 feet).

1926.954(b)(3)(v) Anchorages for work-positioning equipment shall be capable of supporting at least twice the potential impact load of an employee's fall, or 13.3 kilo newtons (3,000 pounds-force), whichever is greater.
Note to paragraph (b)(3)(v): Wood-pole fall-restriction devices meeting American Society of Testing and Materials Standard Specifications for Personal Climbing Equipment, ASTM F887-12^{e1}, are deemed to meet the anchorage-strength requirement when they are used in accordance with manufacturers' instructions.
1926.954(b)(3)(vi) Unless the snaphook is a locking type and designed specifically for the following connections, snaphooks on work-positioning equipment may not be engaged:
1926.954(b)(3)(vi)(A) Directly to webbing, rope, or wire rope;
1926.954(b)(3)(vi)(B) To each other;
1926.954(b)(3)(vi)(C) To a D ring to which another snaphook or other connector is attached;
1926.954(b)(3)(vi)(D) To a horizontal lifeline; or
1926.954(b)(3)(vi)(E) 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.

[79 FR 20699-20700, July 10, 2014]

1926.955 PORTABLE LADDERS AND PLATFORMS

1926.955(a) General. Requirements for portable ladders contained in Subpart X of this part apply in addition to the requirements of this section, except as specifically noted in paragraph (b) of this section.

1926.955(b) Special ladders and platforms. Portable ladders 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 shall meet the following requirements:
1926.955(b)(1) Design load. In the configurations in which they are used, portable platforms shall be capable of supporting without failure at least 2.5 times the maximum intended load.
1926.955(b)(2) Maximum load. Portable ladders and platforms may not be loaded in excess of the working loads for which they are designed.
1926.955(b)(3) Securing in place. Portable ladders and platforms shall be secured to prevent them from becoming dislodged.
1926.955(b)(4) Intended use. Portable ladders and platforms may be used only in applications for which they are designed.

1926.955(c) Conductive ladders. Portable metal ladders and other portable conductive ladders may not be used near exposed energized lines or equipment. However, in specialized high-voltage work, conductive ladders shall be used when the employer demonstrates that nonconductive ladders would present a greater hazard to employees than conductive ladders.

[79 FR 20700-20701, July 10, 2014]

1926.956 HAND AND PORTABLE POWER EQUIPMENT

1926.956(a) General. Paragraph (b) of this section applies to electric equipment connected by cord and plug. Paragraph (c) of this section applies to portable and vehicle-mounted generators used to supply cord- and plug-connected equipment. Paragraph (d) of this section applies to hydraulic and pneumatic tools.

1926.956(b) Cord- and plug-connected equipment. Cord- and plug-connected equipment not covered by Subpart K of this part shall comply with one of the following instead of §1926.302(a)(1):
1926.956(b)(1) The equipment shall 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
1926.956(b)(2) The equipment shall be of the double-insulated type conforming to Subpart K of this part; or
1926.956(b)(3) The equipment shall be connected to the power supply through an isolating transformer with an ungrounded secondary of not more than 50 volts.

1926.956(c) Portable and vehicle-mounted generators. Portable and vehicle-mounted generators used to supply cord- and plug-connected equipment covered by paragraph (b) of this section shall meet the following requirements:
1926.956(c)(1) Equipment to be supplied. 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.
1926.956(c)(2) Equipment grounding. The non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles shall be bonded to the generator frame.
1926.956(c)(3) Bonding the frame. For vehicle-mounted generators, the frame of the generator shall be bonded to the vehicle frame.
1926.956(c)(4) Bonding the neutral conductor. Any neutral conductor shall be bonded to the generator frame.

1926.956(d) Hydraulic and pneumatic tools.
1926.956(d)(1) Hydraulic fluid in insulating tools. Paragraph (d)(1) of §1926.302 does not apply to hydraulic fluid used in insulating sections of hydraulic tools.
1926.956(d)(2) Operating pressure. Safe operating pressures for hydraulic and pneumatic tools, hoses, valves, pipes, filters, and fittings may not be exceeded.
Note to paragraph (d)(2): 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.
1926.956(d)(3) Work near energized parts. A hydraulic or pneumatic tool used where it may contact exposed energized parts shall be designed and maintained for such use.
1926.956(d)(4) Protection against vacuum formation. The hydraulic system supplying a hydraulic tool used where it may contact exposed live parts shall provide protection against loss of insulating value, for the voltage involved, due to the formation of a partial vacuum in the hydraulic line.
Note to paragraph (d)(4): 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.
1926.956(d)(5) Protection against the accumulation of moisture. A pneumatic tool used on energized electric lines or equipment, or used where it may contact exposed live parts, shall provide protection against the accumulation of moisture in the air supply.
1926.956(d)(6) Breaking connections. Pressure shall be released before connections are broken, unless quick-acting, self-closing connectors are used.
1926.956(d)(7) Leaks. Employers must ensure that employees do not use any part of their bodies to locate, or attempt to stop, a hydraulic leak.
1926.956(d)(8) Hoses. Hoses may not be kinked.

[79 FR 20701, July 10, 2014]

1926.957 LIVE-LINE TOOLS

1926.957(a) Design of tools. Live-line tool rods, tubes, and poles shall be designed and constructed to withstand the following minimum tests:

1926.957(a)(1) Fiberglass-reinforced plastic. If the tool is made of fiberglass-reinforced plastic (FRP), it shall withstand 328,100 volts per meter (100,000 volts per foot) of length for 5 minutes, or

Note to paragraph (a)(1): 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 (a)(1) of this section.

1926.957(a)(2) Wood. If the tool is made of wood, it shall withstand 246,100 volts per meter (75,000 volts per foot) of length for 3 minutes, or

1926.957(a)(3) Equivalent tests. The tool shall withstand other tests that the employer can demonstrate are equivalent.

1926.957(b) Condition of tools.

1926.957(b)(1) Daily inspection. Each live-line tool shall be wiped clean and visually inspected for defects before use each day.

1926.957(b)(2) Defects. If any defect or contamination that could adversely affect the insulating qualities or mechanical integrity of the live-line tool is present after wiping, the tool shall be removed from service and examined and tested according to paragraph (b)(3) of this section before being returned to service.

1926.957(b)(3) Biennial inspection and testing. Live-line tools used for primary employee protection shall be removed from service every 2 years, and whenever required under paragraph (b)(2) of this section, for examination, cleaning, repair, and testing as follows:

1926.957(b)(3)(i) Each tool shall be thoroughly examined for defects.

1926.957(b)(3)(ii) If a defect or contamination that could adversely affect the insulating qualities or mechanical integrity of the live-line tool is found, the tool shall be repaired and refinished or shall be permanently removed from service. If no such defect or contamination is found, the tool shall be cleaned and waxed.

1926.957(b)(3)(iii) The tool shall be tested in accordance with paragraphs (b)(3)(iv) and (b)(3)(v) of this section under the following conditions:

1926.957(b)(3)(iii)(A) After the tool has been repaired or refinished; and

1926.957(b)(3)(iii)(B) 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.

1926.957(b)(3)(iv) The test method used shall be designed to verify the tool's integrity along its entire working length and, if the tool is made of fiberglass-reinforced plastic, its integrity under wet conditions.

1926.957(b)(3)(v) The voltage applied during the tests shall be as follows:

1926.957(b)(3)(v)(A) 246,100 volts per meter (75,000 volts per foot) of length for 1 minute if the tool is made of fiberglass, or

1926.957(b)(3)(v)(B) 164,000 volts per meter (50,000 volts per foot) of length for 1 minute if the tool is made of wood, or

1926.957(b)(3)(v)(C) Other tests that the employer can demonstrate are equivalent.

Note to paragraph (b): Guidelines for the examination, cleaning, repairing, and inservice 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.

[79 FR 20701-20702, July 10, 2014]

1926.958 MATERIALS HANDLING AND STORAGE

1926.958(a) General. Materials handling and storage shall comply with applicable material-handling and material-storage requirements in this part, including those in Subparts N and CC of this part.

1926.958(b) Materials storage near energized lines or equipment.
1926.958(b)(1) Unrestricted areas. 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:
1926.958(b)(1)(i) For lines and equipment energized at 50 kilovolts or less, the distance is 3.05 meters (10 feet).
1926.958(b)(1)(ii) 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.
1926.958(b)(2) Restricted areas. In areas restricted to qualified employees, materials may not be stored within the working space about energized lines or equipment.
Note to paragraph (b)(2): Paragraph (b) of §1926.966 specifies the size of the working space.

[79 FR 20702, July 10, 2014]

1926.959 MECHANICAL EQUIPMENT

1926.959(a) General requirements.
1926.959(a)(1) Other applicable requirements. Mechanical equipment shall be operated in accordance with applicable requirements in this part, including Subparts N, O, and CC of this part, except that §1926.600(a)(6) does not apply to operations performed by qualified employees.
1926.959(a)(2) Inspection before use. The critical safety components of mechanical elevating and rotating equipment shall receive a thorough visual inspection before use on each shift.
Note to paragraph (a)(2): 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.
1926.959(a)(3) Operator. The operator of an electric line truck may not leave his or her position at the controls while a load is suspended, unless the employer can demonstrate that no employee (including the operator) is endangered.

1926.959(b) Outriggers.
1926.959(b)(1) Extend outriggers. Mobile equipment, if provided with outriggers, shall be operated with the outriggers extended and firmly set, except as provided in paragraph (b)(3) of this section.
1926.959(b)(2) Clear view. 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.
1926.959(b)(3) Operation without outriggers. 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.

1926.959(c) Applied loads. Mechanical equipment used to lift or move lines or other material shall be used within its maximum load rating and other design limitations for the conditions under which the mechanical equipment is being used.

1926.959(d) Operations near energized lines or equipment.
1926.959(d)(1) Minimum approach distance. Mechanical equipment shall be operated so that the minimum approach distances, established by the employer under §1926.960(c)(1)(i), are maintained from exposed energized lines and equipment. However, the insulated portion of an aerial lift operated by a qualified employee in the lift is exempt from this requirement if the applicable minimum approach distance is maintained between the uninsulated portions of the aerial lift and exposed objects having a different electrical potential.
1926.959(d)(2) Observer. A designated employee other than the equipment operator shall observe the approach distance to exposed lines and equipment and provide timely warnings before the minimum approach distance required by paragraph (d)(1) of this section is reached, unless the employer can demonstrate that the operator can accurately determine that the minimum approach distance is being maintained.

1926.959(d)(3) Extra precautions. If, during operation of the mechanical equipment, that equipment could become energized, the operation also shall comply with at least one of paragraphs (d)(3)(i) through (d)(3)(iii) of this section.
1926.959(d)(3)(i) The energized lines or equipment exposed to contact shall be covered with insulating protective material that will withstand the type of contact that could be made during the operation.
1926.959(d)(3)(ii) The mechanical equipment shall be insulated for the voltage involved. The mechanical equipment shall 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 §1926.960(c)(1)(i).
1926.959(d)(3)(iii) Each employee shall be protected from hazards that could arise from mechanical equipment contact with energized lines or equipment. The measures used shall ensure that employees will not be exposed to hazardous differences in electric potential. Unless the employer can demonstrate that the methods in use protect each employee from the hazards that could arise if the mechanical equipment contacts the energized line or equipment, the measures used shall include all of the following techniques:
1926.959(d)(3)(iii)(A) Using the best available ground to minimize the time the lines or electric equipment remain energized,
1926.959(d)(3)(iii)(B) Bonding mechanical equipment together to minimize potential differences,
1926.959(d)(3)(iii)(C) Providing ground mats to extend areas of equipotential, and
1926.959(d)(3)(iii)(D) Employing insulating protective equipment or barricades to guard against any remaining hazardous electrical potential differences.
Note to paragraph (d)(3)(iii): Appendix C to this subpart contains information on hazardous step and touch potentials and on methods of protecting employees from hazards resulting from such potentials.

[79 FR 20702, July 10, 2014]

1926.960 WORKING ON OR NEAR EXPOSED ENERGIZED PARTS

1926.960(a) Application. This section applies to work on exposed live parts, or near enough to them to expose the employee to any hazard they present.

1926.960(b) General.
1926.960(b)(1) Qualified employees only.
1926.960(b)(1)(i) Only qualified employees may work on or with exposed energized lines or parts of equipment.
1926.960(b)(1)(ii) Only qualified employees may work in areas containing unguarded, uninsulated energized lines or parts of equipment operating at 50 volts or more.
1926.960(b)(2) Treat as energized. Electric lines and equipment shall be considered and treated as energized unless they have been deenergized in accordance with §1926.961.
1926.960(b)(3) At least two employees.
1926.960(b)(3)(i) Except as provided in paragraph (b)(3)(ii) of this section, at least two employees shall be present while any employees perform the following types of work:
1926.960(b)(3)(i)(A) Installation, removal, or repair of lines energized at more than 600 volts,
1926.960(b)(3)(i)(B) Installation, removal, or repair of deenergized lines if an employee is exposed to contact with other parts energized at more than 600 volts,
1926.960(b)(3)(i)(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,
1926.960(b)(3)(i)(D) Work involving the use of mechanical equipment, other than insulated aerial lifts, near parts energized at more than 600 volts, and
1926.960(b)(3)(i)(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 (b)(3)(i)(A) through (b)(3)(i)(D) of this section.
1926.960(b)(3)(ii) Paragraph (b)(3)(i) of this section does not apply to the following operations:
1926.960(b)(3)(ii)(A) Routine circuit switching, when the employer can demonstrate that conditions at the site allow safe performance of this work,
1926.960(b)(3)(ii)(B) 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, and
1926.960(b)(3)(ii)(C) Emergency repairs to the extent necessary to safeguard the general public.

1926.960(c) Live work.
1926.960(c)(1) Minimum approach distances.
1926.960(c)(1)(i) The employer shall establish minimum approach distances no less than the distances computed by Table V-2 for ac systems or Table V-7 for dc systems.
1926.960(c)(1)(ii) No later than April 1, 2015, for voltages over 72.5 kilovolts, the employer shall 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 V-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 shall make any engineering analysis conducted to determine maximum anticipated per unit transient overvoltage available upon request to employees and to the Assistant Secretary or designee for examination and copying.
Note to paragraph (c)(1)(ii): See Appendix B to this subpart 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 over voltages.
1926.960(c)(1)(iii) The employer shall ensure that no employee approaches or takes any conductive object closer to exposed energized parts than the employer's established minimum approach distance, unless:
1926.960(c)(1)(iii)(A) The employee is insulated from the energized part (rubber insulating gloves or rubber insulating gloves and sleeves worn in accordance with paragraph (c)(2) of this section 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
1926.960(c)(1)(iii)(B) The energized part is insulated from the employee and from any other conductive object at a different potential, or
1926.960(c)(1)(iii)(C) The employee is insulated from any other exposed conductive object in accordance with the requirements for live-line barehand work in §1926.964(c).
1926.960(c)(2) Type of insulation.
1926.960(c)(2)(i) When an employee uses rubber insulating gloves as insulation from energized parts (under paragraph (c)(1)(iii)(A) of this section), the employer shall ensure that the employee also uses rubber insulating sleeves. However, an employee need not use rubber insulating sleeves if:
1926.960(c)(2)(i)(A) Exposed energized parts on which the employee is not working are insulated from the employee; and
1926.960(c)(2)(i)(B) When installing insulation for purposes of paragraph (c)(2)(i)(A) of this section, the employee installs the insulation from a position that does not expose his or her upper arm to contact with other energized parts.
1926.960(c)(2)(ii) When an employee uses rubber insulating gloves or rubber insulating gloves and sleeves as insulation from energized parts (under paragraph (c)(1)(iii)(A) of this section), the employer shall ensure that the employee:
1926.960(c)(2)(ii)(A) Puts on the rubber insulating gloves and sleeves in a position where he or she cannot reach into the minimum approach distance, established by the employer under paragraph (c)(1) of this section; and
1926.960(c)(2)(ii)(B) Does not remove the rubber insulating gloves and sleeves until he or she is in a position where he or she cannot reach into the minimum approach distance, established by the employer under paragraph (c)(1) of this section.

1926.960(d) Working position.
1926.960(d)(1) Working from below. The employer shall ensure that each employee, to the extent that other safety-related conditions at the worksite permit, works in a position from which a slip or shock will not bring the employee's body into contact with exposed, uninsulated parts energized at a potential different from the employee's.
1926.960(d)(2) Requirements for working without electrical protective equipment. 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, or performing live-line barehand work under §1926.964(c), the employee shall work from a position where he or she cannot reach into the minimum approach distance, established by the employer under paragraph (c)(1) of this section.

1926.960(e) Making connections. The employer shall ensure that employees make connections as follows:
1926.960(e)(1) Connecting. In connecting deenergized equipment or lines to an energized circuit by means of a conducting wire or device, an employee shall first attach the wire to the deenergized part;
1926.960(e)(2) Disconnecting. When disconnecting equipment or lines from an energized circuit by means of a conducting wire or device, an employee shall remove the source end first; and
1926.960(e)(3) Loose conductors. When lines or equipment are connected to or disconnected from energized circuits, an employee shall keep loose conductors away from exposed energized parts.

1926.960(f) Conductive articles. When an employee performs work within reaching distance of exposed energized parts of equipment, the employer shall 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.

1926.960(g) Protection from flames and electric arcs.
1926.960(g)(1) Hazard assessment. The employer shall assess the workplace to identify employees exposed to hazards from flames or from electric arcs.
1926.960(g)(2) Estimate of available heat energy. For each employee exposed to hazards from electric arcs, the employer shall make a reasonable estimate of the incident heat energy to which the employee would be exposed.
Note 1 to paragraph (g)(2): Appendix E to this subpart provides guidance on estimating available heat energy. The Occupational Safety and Health Administration will deem employers following the guidance in Appendix E to this subpart to be in compliance with paragraph (g)(2) of this section. An employer may choose a method of calculating incident heat energy not included in Appendix E to this subpart if the chosen method reasonably predicts the incident energy to which the employee would be exposed.
Note 2 to paragraph (g)(2): 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.
1926.960(g)(3) Prohibited clothing. The employer shall ensure that each employee who is exposed to hazards from flames or electric arcs does not wear clothing that could melt onto his or her skin or that could ignite and continue to burn when exposed to flames or the heat energy estimated under paragraph (g)(2) of this section.
Note to paragraph (g)(3): 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.
1926.960(g)(4) Flame-resistant clothing. The employer shall ensure that the outer layer of clothing worn by an employee, except for clothing not required to be arc rated under paragraphs (g)(5)(i) through (g)(5)(v) of this section, is flame resistant under any of the following conditions:
1926.960(g)(4)(i) The employee is exposed to contact with energized circuit parts operating at more than 600 volts,
1926.960(g)(4)(ii) An electric arc could ignite flammable material in the work area that, in turn, could ignite the employee's clothing,
1926.960(g)(4)(iii) Molten metal or electric arcs from faulted conductors in the work area could ignite the employee's clothing, or
Note to paragraph (g)(4)(iii): 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.
1926.960(g)(4)(iv) The incident heat energy estimated under paragraph (g)(2) of this section exceeds 2.0 cal/cm2.
1926.960(g)(5) Arc rating. The employer shall ensure that each employee exposed to hazards from electric arcs wears protective clothing and other protective equipment with an arc rating greater than or equal to the heat energy estimated under paragraph (g)(2) of this section whenever that estimate exceeds 2.0 cal/cm2. This protective equipment shall cover the employee's entire body, except as follows:
1926.960(g)(5)(i) 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),
1926.960(g)(5)(ii) Arc-rated protection is not necessary for the employee's feet when the employee is wearing heavy-duty work shoes or boots,
1926.960(g)(5)(iii) Arc-rated protection is not necessary for the employee's head when the employee is wearing head protection meeting §1926.100(b)(2) 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,
1926.960(g)(5)(iv) The protection for the employee's head may consist of head protection meeting §1926.100(b)(2) 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
1926.960(g)(5)(v) 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 (g): See Appendix E to this subpart for further information on the selection of appropriate protection.

1926.960(g)(6) Dates.
1926.960(g)(6)(i) The obligation in paragraph (g)(2) of this section for the employer to make reasonable estimates of incident energy commences January 1, 2015.
1926.960(g)(6)(ii) The obligation in paragraph (g)(4)(iv) of this section for the employer to ensure that the outer layer of clothing worn by an employee is flame-resistant when the estimated incident heat energy exceeds 2.0 cal/cm2 commences April 1, 2015.
1926.960(g)(6)(iii) The obligation in paragraph (g)(5) of this section for the employer to ensure that each employee exposed to hazards from electric arcs wears the required arc-rated protective equipment commences April 1, 2015.

1926.960(h) Fuse handling. When an employee must install or remove fuses with one or both terminals energized at more than 300 volts, or with exposed parts energized at more than 50 volts, the employer shall ensure that the employee uses tools or gloves rated for the voltage. When an employee installs or removes expulsion-type fuses with one or both terminals energized at more than 300 volts, the employer shall ensure that the employee wears eye protection meeting the requirements of Subpart E of this part, uses a tool rated for the voltage, and is clear of the exhaust path of the fuse barrel.

1926.960(i) 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.

1926.960(j) Non-current-carrying metal parts. Non-current-carrying metal parts of equipment or devices, such as transformer cases and circuit-breaker housings, shall be treated as energized at the highest voltage to which these parts are exposed, unless the employer inspects the installation and determines that these parts are grounded before employees begin performing the work.

1926.960(k) Opening and closing circuits under load.
1926.960(k)(1) The employer shall ensure that devices used by employees to open circuits under load conditions are designed to interrupt the current involved.
1926.960(k)(2) The employer shall ensure that devices used by employees to close circuits under load conditions are designed to safely carry the current involved.

Table V-2
AC Live-Line Work Minimum Approach Distance

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

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

MAD = avoid contact

For phase-to-phase system voltages of 301 V to 5kV: [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 750V and 0.61 m otherwise	the inadvertent movement factor

For phase-to-phase system voltages of 5.1 kV to 72.5V: [1,4]

MAD = *M* + *AD*, where

M = 0.61 m	the inadvertent movement factor
A = the applicable value from Table V-4	the altitude correction factor
D = the value from Table V-3 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 subpart	the electrical component of the minimum approach distance

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

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

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

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

0.011 otherwise

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

T = maximum anticipated per-unit transient overvoltage; for phase-to-ground exposures, *T* equals $T_{L\text{-}G}$, the maximum per-unit transient overvoltage, phase-to-ground, determined by the employer under paragraph (c)(1)(ii) of this section; for phase-to-phase exposures, *T* equals $1.35T_{L\text{-}G}+0.45$

A = altitude correction factor from Table V-4

M = 0.31 m, the inadvertent movement factor

a = saturation factor, as follows:

Table V-2
AC Live-Line Work Minimum Approach Distance
(continued)

Phase-to-Ground Exposure

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

Phase-to-Ground Exposure[3]

$V_{Peak} = (1.35T_{L\text{-}G} + 0.45)V_{L\text{-}g}\sqrt{2}$	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 V-5. If the worksite is at an elevation of more than 900 meters (3,000 feet), see footnote 1 to Table V-5

[2] Employers may use the minimum approach distances in Table V-6, except that the employer may not use the minimum approach distances in Table V-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 (3,00 feet), see footnote 1 to Table V-6. Employers may use the minimum approach distance in Table 7 through Table 14 in Appendix B to this subpart, 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 V_{Peak} for phase-to-phase exposures) unless the employer can demonstrate that no insulated tool spans the gap and that no large conductive objects is in the gap.

[4] Until March 31, 2015, employees may use the minimum approach distances in Table 6 in Appendix B to this subpart

TABLE V-3 ELECTRICAL COMPONENT OF THE MINIMUM APPROACH DISTANCE (D; IN METERS) AT 5.1 TO 72.5 KV		
Nominal voltage (kV) phase-to-phase	**Phase-to-ground exposure**	**Phase-to-phase exposure**
	D (m)	**D (m)**
5.1 to 15.0	0.04	0.07
15.1 to 36.0	0.16	0.28
36.1 to 46.0	0.23	0.37
46.1 to 72.5	0.39	0.59

TABLE V-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 V-5 ALTERNATIVE MINIMUM APPROACH DISTANCES (IN METERS OR FEET AND INCHES) FOR VOLTAGES OF 72.5 KV AND LESS [1]				
Nominal voltage (kV) phase-to-phase	**Distance**			
	Phase-to-ground exposure		**Phase-to-phase exposure**	
	m	**ft**	**m**	**ft**
0.50 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 shall determine minimum approach distances by multiplying the distances in this table by the correction factor in Table V-4 corresponding to the altitude of the work.

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

TABLE V-6 ALTERNATIVE MINIMUM APPROACH DISTANCES (IN METERS OR FEET AND INCHES) FOR VOLTAGES OF MORE THAN 72.5 KV [1, 2, 3]				
Voltage range phase to phase (kV)	**Phase-to-ground exposure**		**Phase-to-phase exposure**	
	m	**ft**	**m**	**ft**
72.6 to 121.0	1.13	3.71	1.42	4.66
121.1 to 145.0	1.30	4.27	1.64	5.38
145.1 to 169.0	1.46	4.79	1.94	6.36
169.1 to 242.0	2.01	6.59	3.08	10.10
242.1 to 362.0	3.41	11.19	5.52	18.11
362.1 to 420.0	4.25	13.94	6.81	22.34
420.1 to 550.0	5.07	16.63	8.24	27.03
550.1 to 800.0	6.88	22.57	11.38	37.34

[1]Employers may use the minimum approach distances in this table provided the worksite is at an elevation of 900 meters (3,000 feet) or less. If employees will be working at elevations greater than 900 meters (3,000 feet) above mean sea level, the employer shall determine minimum approach distances by multiplying the distances in this table by the correction factor in Table V-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 shall equal or exceed the values for the indicated voltage ranges.

TABLE V-7 DC LIVE-LINE MINIMUM APPROACH DISTANCE (IN METERS) WITH OVERVOLTAGE FACTOR [1]					
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, bare-hand, and live-line tool conditions. If employees will be working at elevations greater than 900 meters (3,000 feet) above mean sea level, the employer shall determine minimum approach distances by multiplying the distances in this table by the correction factor in Table V-4 corresponding to the altitude of the work.

TABLE V-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

[79 FR 20702-20708, July 10, 2014; 79 FR 56962, September 24, 2014]

1926.961 DEENERGIZING LINES AND EQUIPMENT FOR EMPLOYEE PROTECTION

1926.961(a) Application. This section applies to the deenergizing of transmission and distribution lines and equipment for the purpose of protecting employees. Conductors and parts of electric equipment that have been deenergized under procedures other than those required by this section shall be treated as energized.

1926.961(b) General.
1926.961(b)(1) System operator. If a system operator is in charge of the lines or equipment and their means of disconnection, the employer shall designate one employee in the crew to be in charge of the clearance and shall comply with all of the requirements of paragraph (c) of this section in the order specified.
1926.961(b)(2) No system operator. If no system operator is in charge of the lines or equipment and their means of disconnection, the employer shall designate one employee in the crew to be in charge of the clearance and to perform the functions that the system operator would otherwise perform under this section. All of the requirements of paragraph (c) of this section apply, in the order specified, except as provided in paragraph (b)(3) of this section.
1926.961(b)(3) Single crews working with the means of disconnection under the control of the employee in charge of the clearance. 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 (c)(1), (c)(3), and (c)(5) of this section do not apply. Additionally, the employer does not need to use the tags required by the remaining provisions of paragraph (c) of this section.
1926.961(b)(4) Multiple crews. If two or more crews will be working on the same lines or equipment, then:
1926.961(b)(4)(i) The crews shall coordinate their activities under this section with a single employee in charge of the clearance for all of the crews and follow the requirements of this section as if all of the employees formed a single crew, or
1926.961(b)(4)(ii) Each crew shall independently comply with this section and, if there is no system operator in charge of the lines or equipment, shall have separate tags and coordinate deenergizing and reenergizing the lines and equipment with the other crews.
1926.961(b)(5) Disconnecting means accessible to general public. The employer shall render any disconnecting means that are accessible to individuals outside the employer’s control (for example, the general public) inoperable while the disconnecting means are open for the purpose of protecting employees.

1926.961(c) Deenergizing lines and equipment.
1926.961(c)(1) Request to deenergize. The employee that the employer designates pursuant to paragraph (b) of this section as being in charge of the clearance shall make a request of the system operator to deenergize the particular section of line or equipment. The designated employee becomes the employee in charge (as this term is used in paragraph (c) of this section) and is responsible for the clearance.
1926.961(c)(2) Open disconnecting means. The employer shall ensure that all switches, disconnectors, jumpers, taps, and other means through which known sources of electric energy may be supplied to the particular lines and equipment to be deenergized are open. The employer shall render such means inoperable, unless its design does not so permit, and then ensure that such means are tagged to indicate that employees are at work.
1926.961(c)(3) Automatically and remotely controlled switches. The employer shall ensure that automatically and remotely controlled switches that could cause the opened disconnecting means to close are also tagged at the points of control. The employer shall render the automatic or remote control feature inoperable, unless its design does not so permit.

1926.961(c)(4) Network protectors. The employer need not use the tags mentioned in paragraphs (c)(2) and (c)(3) of this section on a network protector for work on the primary feeder for the network protector's associated network transformer when the employer can demonstrate all of the following conditions:
1926.961(c)(4)(i) Every network protector is maintained so that it will immediately trip open if closed when a primary conductor is deenergized;
1926.961(c)(4)(ii) 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
1926.961(c)(4)(iii) 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.
1926.961(c)(5) Tags. Tags shall prohibit operation of the disconnecting means and shall indicate that employees are at work.
1926.961(c)(6) Test for energized condition. After the applicable requirements in paragraphs (c)(1) through (c)(5) of this section have been followed and the system operator gives a clearance to the employee in charge, the employer shall ensure that the lines and equipment are deenergized by testing the lines and equipment to be worked with a device designed to detect voltage.
1926.961(c)(7) Install grounds. The employer shall ensure the installation of protective grounds as required by §1926.962.
1926.961(c)(8) Consider lines and equipment deenergized. After the applicable requirements of paragraphs (c)(1) through (c)(7) of this section have been followed, the lines and equipment involved may be considered deenergized.
1926.961(c)(9) Transferring clearances. To transfer the clearance, the employee in charge (or the employee's supervisor if the employee in charge must leave the worksite due to illness or other emergency) shall inform the system operator and employees in the crew; and the new employee in charge shall be responsible for the clearance.
1926.961(c)(10) Releasing clearances. To release a clearance, the employee in charge shall:
1926.961(c)(10)(i) Notify each employee under that clearance of the pending release of the clearance;
1926.961(c)(10)(ii) Ensure that all employees under that clearance are clear of the lines and equipment;
1926.961(c)(10)(iii) Ensure that all protective grounds protecting employees under that clearance have been removed; and
1926.961(c)(10)(iv) Report this information to the system operator and then release the clearance.
1926.961(c)(11) Person releasing clearance. Only the employee in charge who requested the clearance may release the clearance, unless the employer transfers responsibility under paragraph (c)(9) of this section.
1926.961(c)(12) Removal of tags. No one may remove tags without the release of the associated clearance as specified under paragraphs (c)(10) and (c)(11) of this section.
1926.961(c)(13) Reenergizing lines and equipment. The employer shall ensure that no one initiates action to reenergize the lines or equipment at a point of disconnection until all protective grounds have been removed, all crews working on the lines or equipment release their clearances, all employees are clear of the lines and equipment, and all protective tags are removed from that point of disconnection.

[79 FR 20708-20709, July 10, 2014]

1926.962 GROUNDING FOR THE PROTECTION OF EMPLOYEES

1926.962(a) Application. This section applies to grounding of transmission and distribution lines and equipment for the purpose of protecting employees. Paragraph (d) of this section also applies to protective grounding of other equipment as required elsewhere in this Subpart.
Note to paragraph (a): This section covers grounding of transmission and distribution lines and equipment when this subpart requires protective grounding and whenever the employer chooses to ground such lines and equipment for the protection of employees.

1926.962(b) General. For any employee to work transmission and distribution lines or equipment as deenergized, the employer shall ensure that the lines or equipment are deenergized under the provisions of §1926.961 and shall ensure proper grounding of the lines or equipment as specified in paragraphs (c) through (h) of this section. However, if the employer can demonstrate that installation of a ground is impracticable or that the conditions resulting from the installation of a ground would present greater hazards to employees than working without grounds, the lines and equipment may be treated as deenergized provided that the employer establishes that all of the following conditions apply:
1926.962(b)(1) Deenergized. The employer ensures that the lines and equipment are deenergized under the provisions of §1926.961.
1926.962(b)(2) No possibility of contact. There is no possibility of contact with another energized source.
1926.962(b)(3) No induced voltage. The hazard of induced voltage is not present.

1926.962(c) Equipotential zone. Temporary protective grounds shall be placed at such locations and arranged in such a manner that the employer can demonstrate will prevent each employee from being exposed to hazardous differences in electric potential.
Note to paragraph (c): Appendix C to this subpart contains guidelines for establishing the equipotential zone required by this paragraph. The Occupational Safety and Health Administration will deem grounding practices meeting these guidelines as complying with paragraph (c) of this section.

1926.962(d) Protective grounding equipment.
1926.962(d)(1) Ampacity.
1926.962(d)(1)(i) Protective grounding equipment shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.
1926.962(d)(1)(ii) Protective grounding equipment shall have an ampacity greater than or equal to that of No. 2 AWG copper.
1926.962(d)(2) Impedance. Protective grounds shall have an impedance low enough so that they do not delay the operation of protective devices in case of accidental energizing of the lines or equipment.
Note to paragraph (d): 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.

1926.962(e) Testing. The employer shall 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.

1926.962(f) Connecting and removing grounds.
1926.962(f)(1) Order of connection. The employer shall ensure that, when an employee attaches a ground to a line or to equipment, the employee attaches the ground-end connection first and then attaches the other end by means of a live-line tool. 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.
1926.962(f)(2) Order of removal. The employer shall ensure that, when an employee removes a ground, the employee removes the grounding device from the line or equipment using a live-line tool before he or she removes the ground-end connection. 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.

1926.962(g) Additional precautions. The employer shall ensure that, when an employee performs work on a cable at a location remote from the cable terminal, the cable is not grounded at the cable terminal if there is a possibility of hazardous transfer of potential should a fault occur.

1926.962(h) Removal of grounds for test. The employer may permit employees to remove grounds temporarily during tests. During the test procedure, the employer shall ensure that each employee uses insulating equipment, shall isolate each employee from any hazards involved, and shall implement any additional measures necessary to protect each exposed employee in case the previously grounded lines and equipment become energized.

[79 FR 20709-20710, July 10, 2014]

1926.963 TESTING AND TEST FACILITIES

1926.963(a) Application. This section provides for safe work practices for high-voltage and high-power testing performed in laboratories, shops, and substations, and in the field and on electric transmission and distribution lines and equipment. It applies only to testing involving interim measurements using high voltage, high power, or combinations of high voltage and high power, and not to testing involving continuous measurements as in routine metering, relaying, and normal line work.
Note to paragraph (a): OSHA considers routine inspection and maintenance measurements made by qualified employees to be routine line work not included in the scope of this section, provided that the hazards related to the use of intrinsic high voltage or high-power sources require only the normal precautions associated with routine work specified in the other paragraphs of this subpart. Two typical examples of such excluded test work procedures are "phasing-out" testing and testing for a "no-voltage" condition.

1926.963(b) General requirements.
1926.963(b)(1) Safe work practices. The employer shall establish and enforce work practices for the protection of each worker from the hazards of high-voltage or high-power testing at all test areas, temporary and permanent. Such work practices shall include, 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.
1926.963(b)(2) Training. The employer shall ensure that each employee, upon initial assignment to the test area, receives training in safe work practices, with retraining provided as required by §1926.950(b).

1926.963(c) Safeguarding of test areas.
1926.963(c)(1) Safeguarding. The employer shall provide safeguarding within test areas to control access to test equipment or to apparatus under test that could become energized as part of the testing by either direct or inductive coupling and to prevent accidental employee contact with energized parts.
1926.963(c)(2) Permanent test areas. The employer shall guard permanent test areas with walls, fences, or other barriers designed to keep employees out of the test areas.
1926.963(c)(3) Temporary test areas. In field testing, or at a temporary test site not guarded by permanent fences and gates, the employer shall ensure the use of one of the following means to prevent employees without authorization from entering:
1926.963(c)(3)(i) Distinctively colored safety tape supported approximately waist high with safety signs attached to it,
1926.963(c)(3)(ii) A barrier or barricade that limits access to the test area to a degree equivalent, physically and visually, to the barricade specified in paragraph (c)(3)(i) of this section, or
1926.963(c)(3)(iii) One or more test observers stationed so that they can monitor the entire area.
1926.963(c)(4) Removal of safeguards. The employer shall ensure the removal of the safeguards required by paragraph (c)(3) of this section when employees no longer need the protection afforded by the safeguards.

1926.963(d) Grounding practices.
1926.963(d)(1) Establish and implement practices. The employer shall establish and implement safe grounding practices for the test facility.
1926.963(d)(1)(i) The employer shall maintain at ground potential all conductive parts accessible to the test operator while the equipment is operating at high voltage.
1926.963(d)(1)(ii) Wherever ungrounded terminals of test equipment or apparatus under test may be present, they shall be treated as energized until tests demonstrate that they are deenergized.

1926.963(d)(2) Installation of grounds. The employer shall ensure either that visible grounds are applied automatically, or that employees using properly insulated tools manually apply visible grounds, to the high-voltage circuits after they are deenergized and before any employee performs work on the circuit or on the item or apparatus under test. Common ground connections shall be solidly connected to the test equipment and the apparatus under test.
1926.963(d)(3) Isolated ground return. In high-power testing, the employer shall provide an isolated ground-return conductor system designed to prevent the intentional passage of current, with its attendant voltage rise, from occurring in the ground grid or in the earth. However, the employer need not provide an isolated ground-return conductor if the employer can demonstrate that both of the following conditions exist:
1926.963(d)(3)(i) The employer cannot provide an isolated ground-return conductor due to the distance of the test site from the electric energy source, and
1926.963(d)(3)(ii) The employer protects employees from any hazardous step and touch potentials that may develop during the test.
Note to paragraph (d)(3)(ii): See Appendix C to this subpart for information on measures that employers can take to protect employees from hazardous step and touch potentials.
1926.963(d)(4) Equipment grounding conductors. For tests in which using the equipment grounding conductor in the equipment power cord to ground the test equipment would result in greater hazards to test personnel or prevent the taking of satisfactory measurements, the employer may use a ground clearly indicated in the test set-up if the employer can demonstrate that this ground affords protection for employees equivalent to the protection afforded by an equipment grounding conductor in the power supply cord.
1926.963(d)(5) Grounding after tests. The employer shall ensure that, when any employee enters the test area after equipment is deenergized, a ground is placed on the high-voltage terminal and any other exposed terminals.
1926.963(d)(5)(i) Before any employee applies a direct ground, the employer shall discharge high capacitance equipment or apparatus through a resistor rated for the available energy.
1926.963(d)(5)(ii) A direct ground shall be applied to the exposed terminals after the stored energy drops to a level at which it is safe to do so.
1926.963(d)(6) Grounding test vehicles. If the employer uses a test trailer or test vehicle in field testing, its chassis shall be grounded. The employer shall protect each employee against hazardous touch potentials with respect to the vehicle, instrument panels, and other conductive parts accessible to employees with bonding, insulation, or isolation.

1926.963(e) Control and measuring circuits.
1926.963(e)(1) Control wiring. 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.
1926.963(e)(2) Instruments. The employer shall isolate meters and other instruments with accessible terminals or parts from test personnel to protect against hazards that could arise should such terminals and parts become energized during testing. If the employer provides this isolation by locating test equipment in metal compartments with viewing windows, the employer shall provide interlocks to interrupt the power supply when someone opens the compartment cover.
1926.963(e)(3) Routing temporary wiring. The employer shall protect temporary wiring and its connections against damage, accidental interruptions, and other hazards. To the maximum extent possible, the employer shall keep signal, control, ground, and power cables separate from each other.
1926.963(e)(4) Test observer. If any employee will be present in the test area during testing, a test observer shall be present. The test observer shall be capable of implementing the immediate deenergizing of test circuits for safety purposes.

1926.963(f) Safety check.
1926.963(f)(1) Before each test. Safety practices governing employee work at temporary or field test areas shall provide, at the beginning of each series of tests, for a routine safety check of such test areas.
1926.963(f)(2) Conditions to be checked. The test operator in charge shall conduct these routine safety checks before each series of tests and shall verify at least the following conditions:
1926.963(f)(2)(i) Barriers and safeguards are in workable condition and placed properly to isolate hazardous areas;
1926.963(f)(2)(ii) System test status signals, if used, are in operable condition;
1926.963(f)(2)(iii) Clearly marked test-power disconnects are readily available in an emergency;
1926.963(f)(2)(iv) Ground connections are clearly identifiable;
1926.963(f)(2)(v) Personal protective equipment is provided and used as required by Subpart E of this part and by this subpart; and
1926.963(f)(2)(vi) Proper separation between signal, ground, and power cables.

[79 FR 20710-20711, July 10, 2014]

1926.964 OVERHEAD LINES AND LIVE-LINE BAREHAND WORK

1926.964(a) General.
1926.964(a)(1) Application. This section provides additional requirements for work performed on or near overhead lines and equipment and for live-line barehand work.
1926.964(a)(2) Checking structure before climbing. Before allowing employees to subject elevated structures, such as poles or towers, to such stresses as climbing or the installation or removal of equipment may impose, the employer shall ascertain that the structures are capable of sustaining the additional or unbalanced stresses. If the pole or other structure cannot withstand the expected loads, the employer shall brace or otherwise support the pole or structure so as to prevent failure.
Note to paragraph (a)(2): Appendix D to this subpart contains test methods that employers can use in ascertaining whether a wood pole is capable of sustaining the forces imposed by an employee climbing the pole. This paragraph also requires the employer to ascertain that the pole can sustain all other forces imposed by the work employees will perform.
1926.964(a)(3) Setting and moving poles.
1926.964(a)(3)(i) When a pole is set, moved, or removed near an exposed energized overhead conductor, the pole may not contact the conductor.
1926.964(a)(3)(ii) When a pole is set, moved, or removed near an exposed energized overhead conductor, the employer shall ensure that each employee wears electrical protective equipment or uses insulated devices when handling the pole and that no employee contacts the pole with uninsulated parts of his or her body.
1926.964(a)(3)(iii) To protect employees from falling into holes used for placing poles, the employer shall physically guard the holes, or ensure that employees attend the holes, whenever anyone is working nearby.

1926.964(b) Installing and removing overhead lines. The following provisions apply to the installation and removal of overhead conductors or cable (overhead lines).
1926.964(b)(1) Tension stringing method. When lines that employees are installing or removing can contact energized parts, the employer shall 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.
1926.964(b)(2) Conductors, cables, and pulling and tensioning equipment. For conductors, cables, and pulling and tensioning equipment, the employer shall provide the protective measures required by §1926.959(d)(3) 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:
1926.964(b)(2)(i) Failure of the pulling or tensioning equipment,
1926.964(b)(2)(ii) Failure of the conductor or cable being pulled, or
1926.964(b)(2)(iii) Failure of the previously installed lines or equipment.
1926.964(b)(3) Disable automatic-reclosing feature. 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 shall render inoperable the automatic-reclosing feature of these devices.
1926.964(b)(4) Induced voltage.
1926.964(b)(4)(i) Before employees install lines parallel to existing energized lines, the employer shall make a determination of the approximate voltage to be induced in the new lines, or work shall proceed on the assumption that the induced voltage is hazardous.
1926.964(b)(4)(ii) 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 shall be placed at such locations and arranged in such a manner that the employer can demonstrate will prevent exposure of each employee to hazardous differences in electric potential.
Note to paragraph (b)(4)(ii): Appendix C to this subpart contains guidelines for protecting employees from hazardous differences in electric potential as required by this paragraph.
Note to paragraph (b)(4): 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.
1926.964(b)(5) Safe operating condition. Reel-handling equipment, including pulling and tensioning devices, shall be in safe operating condition and shall be leveled and aligned.
1926.964(b)(6) Load ratings. The employer shall ensure that employees do not exceed load ratings of stringing lines, pulling lines, conductor grips, load-bearing hardware and accessories, rigging, and hoists.
1926.964(b)(7) Defective pulling lines. The employer shall repair or replace defective pulling lines and accessories.
1926.964(b)(8) Conductor grips. The employer shall ensure that employees do not use conductor grips on wire rope unless the manufacturer specifically designed the grip for this application.

1926.964(b)(9) Communications. The employer shall ensure that employees maintain reliable communications, through two-way radios or other equivalent means, between the reel tender and the pulling rig operator.
1926.964(b)(10) Operation of pulling rig. Employees may operate the pulling rig only when it is safe to do so.
Note to paragraph (b)(10): Examples of unsafe conditions include: employees in locations prohibited by paragraph (b)(11) of this section, conductor and pulling line hang-ups, and slipping of the conductor grip.
1926.964(b)(11) Working under overhead operations. While a power-driven device is pulling the conductor or pulling line and the conductor or pulling line is in motion, the employer shall ensure that employees are not directly under overhead operations or on the crossarm, except as necessary for the employees to guide the stringing sock or board over or through the stringing sheave.

1926.964(c) Live-line barehand work. In addition to other applicable provisions contained in this subpart, the following requirements apply to live-line barehand work:
1926.964(c)(1) Training. Before an employee uses or supervises the use of the live-line barehand technique on energized circuits, the employer shall ensure that the employee completes training conforming to §1926.950(b) in the technique and in the safety requirements of paragraph (c) of this section.
1926.964(c)(2) Existing conditions. Before any employee uses the live-line barehand technique on energized high-voltage conductors or parts, the employer shall ascertain the following information in addition to information about other existing conditions required by §1926.950(d):
1926.964(c)(2)(i) The nominal voltage rating of the circuit on which employees will perform the work,
1926.964(c)(2)(ii) The clearances to ground of lines and other energized parts on which employees will perform the work, and
1926.964(c)(2)(iii) The voltage limitations of equipment employees will use.
1926.964(c)(3) Insulated tools and equipment.
1926.964(c)(3)(i) The employer shall ensure that the insulated equipment, insulated tools, and aerial devices and platforms used by employees are designed, tested, and made for live-line barehand work.
1926.964(c)(3)(ii) The employer shall ensure that employees keep tools and equipment clean and dry while they are in use.
1926.964(c)(4) Disable automatic-reclosing feature. The employer shall render inoperable the automatic-reclosing feature of circuit-interrupting devices protecting the lines if the design of the devices permits.
1926.964(c)(5) Adverse weather conditions. The employer shall ensure that employees do not perform work when adverse weather conditions would make the work hazardous even after the employer implements the work practices required by this subpart. Additionally, employees may not perform work when winds reduce the phase-to-phase or phase-to-ground clearances at the work location below the minimum approach distances specified in paragraph (c)(13) of this section, unless insulating guards cover the grounded objects and other lines and equipment.
Note to paragraph (c)(5): Thunderstorms in the vicinity, high winds, snow storms, and ice storms are examples of adverse weather conditions that make live-line barehand work too hazardous to perform safely even after the employer implements the work practices required by this subpart.
1926.964(c)(6) Bucket liners and electrostatic shielding. The employer shall provide and ensure that employees use a conductive bucket liner or other conductive device for bonding the insulated aerial device to the energized line or equipment.
1926.964(c)(6)(i) The employee shall be connected to the bucket liner or other conductive device by the use of conductive shoes, leg clips, or other means.
1926.964(c)(6)(ii) Where differences in potentials at the worksite pose a hazard to employees, the employer shall provide electrostatic shielding designed for the voltage being worked.
1926.964(c)(7) Bonding the employee to the energized part. The employer shall ensure that, before the employee contacts the energized part, the employee bonds the conductive bucket liner or other conductive device to the energized conductor by means of a positive connection. This connection shall remain attached to the energized conductor until the employee completes the work on the energized circuit.
1926.964(c)(8) Aerial-lift controls. Aerial lifts used for live-line barehand work shall have dual controls (lower and upper) as follows:
1926.964(c)(8)(i) The upper controls shall be within easy reach of the employee in the bucket. On a two-bucket-type lift, access to the controls shall be within easy reach of both buckets.
1926.964(c)(8)(ii) The lower set of controls shall be near the base of the boom and shall be designed so that they can override operation of the equipment at any time.
1926.964(c)(9) Operation of lower controls. Lower (ground-level) lift controls may not be operated with an employee in the lift except in case of emergency.
1926.964(c)(10) Check controls. The employer shall ensure that, before employees elevate an aerial lift into the work position, the employees check all controls (ground level and bucket) to determine that they are in proper working condition.
1926.964(c)(11) Body of aerial lift truck. The employer shall ensure that, before employees elevate the boom of an aerial lift, the employees ground the body of the truck or barricade the body of the truck and treat it as energized.

1926.964(c)(12) Boom-current test. The employer shall ensure that employees perform a boom-current test before starting work each day, each time during the day when they encounter a higher voltage, and when changed conditions indicate a need for an additional test.
1926.964(c)(12)(i) This test shall consist of placing the bucket in contact with an energized source equal to the voltage to be encountered for a minimum of 3 minutes.
1926.964(c)(12)(ii) The leakage current may not exceed 1 microampere per kilovolt of nominal phase-to-ground voltage.
1926.964(c)(12)(iii) The employer shall immediately suspend work from the aerial lift when there is any indication of a malfunction in the equipment.
1926.964(c)(13) Minimum approach distance. The employer shall ensure that employees maintain the minimum approach distances, established by the employer under §1926.960(c)(1)(i), from all grounded objects and from lines and equipment at a potential different from that to which the live-line barehand equipment is bonded, unless insulating guards cover such grounded objects and other lines and equipment.
1926.964(c)(14) Approaching, leaving, and bonding to energized part. The employer shall ensure that, while an employee is approaching, leaving, or bonding to an energized circuit, the employee maintains the minimum approach distances, established by the employer under §1926.960(c)(1)(i), between the employee and any grounded parts, including the lower boom and portions of the truck and between the employee and conductive objects energized at different potentials.
1926.964(c)(15) Positioning bucket near energized bushing or insulator string. While the bucket is alongside an energized bushing or insulator string, the employer shall ensure that employees maintain the phase-to-ground minimum approach distances, established by the employer under §1926.960(c)(1)(i), between all parts of the bucket and the grounded end of the bushing or insulator string or any other grounded surface.
1926.964(c)(16) Handlines. The employer shall ensure that employees do not use handlines between the bucket and the boom or between the bucket and the ground. However, employees may use nonconductive-type handlines from conductor to ground if not supported from the bucket. The employer shall ensure that no one uses ropes used for live-line barehand work for other purposes.
1926.964(c)(17) Passing objects to employee. The employer shall ensure that employees do not pass uninsulated equipment or material between a pole or structure and an aerial lift while an employee working from the bucket is bonded to an energized part.
1926.964(c)(18) Nonconductive measuring device. A nonconductive measuring device shall be readily accessible to employees performing live-line barehand work to assist them in maintaining the required minimum approach distance.

1926.964(d) Towers and structures. The following requirements apply to work performed on towers or other structures that support overhead lines.
1926.964(d)(1) Working beneath towers and structures. The employer shall 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.
1926.964(d)(2) Tag lines. The employer shall ensure that employees use tag lines or other similar devices to maintain control of tower sections being raised or positioned, unless the employer can demonstrate that the use of such devices would create a greater hazard to employees.
1926.964(d)(3) Disconnecting load lines. The employer shall ensure that employees do not detach the loadline from a member or section until they safely secure the load.
1926.964(d)(4) Adverse weather conditions. The employer shall 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 subpart.
Note to paragraph (d)(4): 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 subpart.

[79 FR 20711-20713, July 10, 2014]

1926.965 UNDERGROUND ELECTRICAL INSTALLATIONS

1926.965(a) Application. This section provides additional requirements for work on underground electrical installations.

1926.965(b) Access. The employer shall 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.

1926.965(c) Lowering equipment into manholes.
1926.965(c)(1) Hoisting equipment. Equipment used to lower materials and tools into manholes or vaults shall be capable of supporting the weight to be lowered and shall be checked for defects before use.
1926.965(c)(2) Clear the area of employees. Before anyone lowers tools or material into the opening for a manhole or vault, each employee working in the manhole or vault shall be clear of the area directly under the opening.

1926.965(d) Attendants for manholes and vaults.
1926.965(d)(1) When required. While work is being performed in a manhole or vault containing energized electric equipment, an employee with first-aid training shall be available on the surface in the immediate vicinity of the manhole or vault entrance to render emergency assistance.
1926.965(d)(2) Brief entries allowed. Occasionally, the employee on the surface may briefly enter a manhole or vault to provide nonemergency assistance.
Note 1 to paragraph (d)(2): Paragraph (h) of 1926.953 may also require an attendant and does not permit this attendant to enter the manhole or vault.
Note 2 to paragraph (d)(2): Paragraph (b)(1)(ii) of §1926.960 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.
1926.965(d)(3) Entry without attendant. 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.
1926.965(d)(4) Communications. The employer shall ensure that employees maintain reliable communications, through two-way radios or other equivalent means, among all employees involved in the job.

1926.965(e) Duct rods. The employer shall ensure that, if employees use duct rods, the employees install the duct rods in the direction presenting the least hazard to employees. The employer shall station an employee at the far end of the duct line being rodded to ensure that the employees maintain the required minimum approach distances.

1926.965(f) Multiple cables. When multiple cables are present in a work area, the employer shall identify the cable to be worked by electrical means, unless its identity is obvious by reason of distinctive appearance or location or by other readily apparent means of identification. The employer shall protect cables other than the one being worked from damage.

1926.965(g) Moving cables. Except when paragraph (h)(2) of this section permits employees to perform work that could cause a fault in an energized cable in a manhole or vault, the employer shall ensure that employees inspect energized cables to be moved for abnormalities.

1926.965(h) Protection against faults.
1926.965(h)(1) Cables with abnormalities. Where a cable in a manhole or vault has one or more abnormalities that could lead to a fault or be an indication of an impending fault, the employer shall deenergize the cable with the abnormality before any employee may work in the manhole or vault, 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 shall 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.
1926.965(h)(2) Work-related faults. If the work employees will perform in a manhole or vault could cause a fault in a cable, the employer shall deenergize that cable before any employee works in the manhole or vault, 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.

1926.965(h)(2)(i) Sheath continuity. When employees perform work on buried cable or on cable in a manhole or vault, the employer shall maintain metallic-sheath continuity, or the cable sheath shall be treated as energized.

[79 FR 20713, July 10, 2014]

1926.966 SUBSTATIONS

1926.966(a) Application. This section provides additional requirements for substations and for work performed in them.

1926.966(b) Access and working space. The employer shall provide and maintain sufficient access and working space about electric equipment to permit ready and safe operation and maintenance of such equipment by employees.
Note to paragraph (b): 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 (b) of this section. The Occupational Safety and Health Administration will determine whether an installation that does not conform to this ANSI standard complies with paragraph (b) of this section based on the following criteria:

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

(2) Whether the configuration of the installation enables employees to maintain the minimum approach distances, established by the employer under §1926.960(c)(1)(i), while the employees are working on exposed, energized parts; and

(3) 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.

1926.966(c) Draw-out-type circuit breakers. The employer shall ensure that, when employees remove or insert draw-out type circuit breakers, the breaker is in the open position. The employer shall also render the control circuit inoperable if the design of the equipment permits.

1926.966(d) Substation fences. Conductive fences around substations shall be grounded. When a substation fence is expanded or a section is removed, fence sections shall be isolated, grounded, or bonded as necessary to protect employees from hazardous differences in electric potential.
Note to paragraph (d): IEEE Std 80-2000, IEEE Guide for Safety in AC Substation Grounding, contains guidelines for protection against hazardous differences in electric potential.

1926.966(e) Guarding of rooms and other spaces containing electric supply equipment.
1926.966(e)(1) When to guard rooms and other spaces. Rooms and other spaces in which electric supply lines or equipment are installed shall meet the requirements of paragraphs (e)(2) through (e)(5) of this section under the following conditions:
1926.966(e)(1)(i) 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,
1926.966(e)(1)(ii) 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 (f)(1) of this section, or
1926.966(e)(1)(iii) If live parts operating at more than 600 volts to ground are within the room or other space, unless:
1926.966(e)(1)(iii)(A) 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
1926.966(e)(1)(iii)(B) 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.
1926.966(e)(2) Prevent access by unqualified persons. Fences, screens, partitions, or walls shall enclose the rooms and other spaces so as to minimize the possibility that unqualified persons will enter.
1926.966(e)(3) Restricted entry. Unqualified persons may not enter the rooms or other spaces while the electric supply lines or equipment are energized.
1926.966(e)(4) Warning signs. The employer shall display signs at entrances to the rooms and other spaces warning unqualified persons to keep out.

1926.966(e)(5) Entrances to rooms and other. The employer shall 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.

1926.966(f) Guarding of energized parts.
1926.966(f)(1) Type of guarding. The employer shall 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 (f)(1): 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 (f)(1) of this section. The Occupational Safety and Health Administration will determine whether an installation that does not conform to this ANSI standard complies with paragraph (f)(1) of this section based on the following criteria:

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

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

(3) 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.

1926.966(f)(2) Maintaining guards during operation. Except for fuse replacement and other necessary access by qualified persons, the employer shall maintain guarding of energized parts within a compartment during operation and maintenance functions to prevent accidental contact with energized parts and to prevent dropped tools or other equipment from contacting energized parts.
1926.966(f)(3) Temporary removal of guards. Before guards are removed from energized equipment, the employer shall install barriers around the work area to prevent employees who are not working on the equipment, but who are in the area, from contacting the exposed live parts.

1926.966(g) Substation entry.
1926.966(g)(1) Report upon entering. Upon entering an attended substation, each employee, other than employees regularly working in the station, shall report his or her presence to the employee in charge of substation activities to receive information on special system conditions affecting employee safety.
1926.966(g)(2) Job briefing. The job briefing required by §1926.952 shall cover information on special system conditions affecting employee safety, including the location of energized equipment in or adjacent to the work area and the limits of any deenergized work area.

[79 FR 20713-20714, July 10, 2014]

1926.967 SPECIAL CONDITIONS

1926.967(a) Capacitors. The following additional requirements apply to work on capacitors and on lines connected to capacitors.
Note to paragraph (a): See §§1926.961 and 1926.962 for requirements pertaining to the deenergizing and grounding of capacitor installations.
1926.967(a)(1) Disconnect from energized source. Before employees work on capacitors, the employer shall disconnect the capacitors from energized sources and short circuit the capacitors. The employer shall ensure that the employee short circuiting the capacitors waits at least 5 minutes from the time of disconnection before applying the short circuit,
1926.967(a)(2) Short circuiting units. Before employees handle the units, the employer shall short circuit each unit in series-parallel capacitor banks between all terminals and the capacitor case or its rack. If the cases of capacitors are on ungrounded substation racks, the employer shall bond the racks to ground.
1926.967(a)(3) Short circuiting connected lines. The employer shall short circuit any line connected to capacitors before the line is treated as deenergized.

1926.967(b) Current transformer secondaries. The employer shall ensure that employees do not open the secondary of a current transformer while the transformer is energized. If the employer cannot deenergize the primary of the current transformer before employees perform work on an instrument, a relay, or other section of a current transformer secondary circuit, the employer shall bridge the circuit so that the current transformer secondary does not experience an open-circuit condition.

1926.967(c) Series street lighting.
1926.967(c)(1) Applicable requirements. If the open-circuit voltage exceeds 600 volts, the employer shall ensure that employees work on series street lighting circuits in accordance with §1926.964 or §1926.965, as appropriate.
1926.967(c)(2) Opening a series loop. Before any employee opens a series loop, the employer shall deenergize the street lighting transformer and isolate it from the source of supply or shall bridge the loop to avoid an open-circuit condition.

1926.967(d) Illumination. The employer shall provide sufficient illumination to enable the employee to perform the work safely.
Note to paragraph (d): See §1926.56, which requires specific levels of illumination.

1926.967(e) Protection against drowning.
1926.967(e)(1) Personal flotation devices. Whenever an employee may be pulled or pushed, or might fall, into water where the danger of drowning exists, the employer shall provide the employee with, and shall ensure that the employee uses, a personal flotation device meeting §1926.106.
1926.967(e)(2) Maintaining flotation devices in safe condition. The employer shall maintain each personal flotation device in safe condition and shall inspect each personal flotation device frequently enough to ensure that it does not have rot, mildew, water saturation, or any other condition that could render the device unsuitable for use.
1926.967(e)(3) Crossing bodies of water. An employee may cross streams or other bodies of water only if a safe means of passage, such as a bridge, is available.

1926.967(f) Excavations. Excavation operations shall comply with Subpart P of this part.

1926.967(g) Employee protection in public work areas.
1926.967(g)(1) Traffic control devices. Traffic-control signs and traffic-control devices used for the protection of employees shall meet §1926.200(g)(2).
1926.967(g)(2) Controlling traffic. Before employees begin work in the vicinity of vehicular or pedestrian traffic that may endanger them, the employer shall place warning signs or flags and other traffic control devices in conspicuous locations to alert and channel approaching traffic.
1926.967(g)(3) Barricades. The employer shall use barricades where additional employee protection is necessary.
1926.967(g)(4) Excavated areas. The employer shall protect excavated areas with barricades.
1926.967(g)(5) Warning lights. The employer shall display warning lights prominently at night.

1926.967(h) 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 §1926.967 apply if employees will work the lines or equipment as energized, and the requirements of §§1926.961 and 1926.962 apply if employees will work the lines or equipment as deenergized.

1926.967(i) Lasers. The employer shall install, adjust, and operate laser equipment in accordance with §1926.54.

1926.967(j) Hydraulic fluids. Hydraulic fluids used for the insulated sections of equipment shall provide insulation for the voltage involved.

1926.967(k) Communication facilities.
1926.967(k)(1) Microwave transmission.
1926.967(k)(1)(i) The employer shall ensure that no employee looks into an open waveguide or antenna connected to an energized microwave source.
1926.967(k)(1)(ii) 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) of this chapter, the employer shall post the area with warning signs containing the warning symbol described in §1910.97(a)(3) of this chapter. The lower half of the warning symbol shall include the following statements, or ones that the employer can demonstrate are equivalent: "Radiation in this area may exceed hazard limitations and special precautions are required. Obtain specific instruction before entering."
1926.967(k)(1)(iii) When an employee works in an area where the electromagnetic radiation could exceed the radiation protection guide, the employer shall institute measures that ensure that the employee's exposure is not greater than that permitted by that guide. Such measures may include administrative and engineering controls and personal protective equipment.
1926.967(k)(2) Power-line carrier. The employer shall 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 this subpart pertaining to work on energized lines.

[79 FR 20714-20715, July 10, 2014]

1926.968 DEFINITIONS

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.

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.

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.

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

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

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

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.

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

Cable sheath. A conductive protective covering applied to cables.

Note to the definition of "cable sheath": A cable sheath may consist of multiple layers one or more of which is conductive.

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

Clearance (between objects). The clear distance between two objects measured surface to surface.

Clearance (for work). Authorization to perform specified work or permission to enter a restricted area.

Communication lines. (See *Lines*; (1) *Communication lines*.)

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

Contract employer. An employer, other than a host employer, that performs work covered by Subpart V of this part under contract.

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

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

Deenergized. Free from any electrical connection to a source of potential difference and from electric charge; not having a potential 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).

Designated employee (designated person). An employee (or person) who is assigned by the employer to perform specific duties under the terms of this subpart and who has sufficient knowledge of the construction and operation of the equipment, and the hazards involved, to perform his or her duties safely.

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

Electric supply equipment. Equipment that produces, modifies, regulates, controls, or safeguards a supply of electric energy.

Electric supply lines. (See "Lines; (2) Electric supply lines.")

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

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

Note to the definition of "Enclosed space". The Occupational Safety and Health Administration 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 subpart. Similarly, the Occupational Safety and Health Administration 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 subpart. Such spaces meet the definition of permit spaces in subpart AA of this part, and entry into them must conform to that standard.

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

Energy source. Any electrical, mechanical, hydraulic, pneumatic, chemical, nuclear, thermal, or other energy source that could cause injury to employees.

Entry (as used in §1926.953). 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.

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

Exposed, Exposed to contact (as applied to energized parts). Not isolated or guarded.

Fall restraint system. A fall protection system that prevents the user from falling any distance.

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.

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.

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

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

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

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:

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

Note 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.

3. Atmospheric oxygen concentration below 19.5 percent or above 23.5 percent;
4. Atmospheric concentration of any substance for which a dose or a permissible exposure limit is published in Subpart D, *Occupational Health and Environmental Controls*, or in Subpart Z, *Toxic and Hazardous Substances*, of this part and which could result in employee exposure in excess of its dose or permissible exposure limit;

Note 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.

5. 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 the Occupational Safety and Health Administration has not determined a dose or permissible exposure limit, other sources of information, such as Material Safety Data Sheets that comply with the Hazard Communication Standard, §1926.59, published information, and internal documents can provide guidance in establishing acceptable atmospheric conditions.

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.

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.

High wind. A wind of such velocity that one or more of the following hazards would be present:

1. The wind could blow an employee from an elevated location,
2. The wind could cause an employee or equipment handling material to lose control of the material, or
3. The wind would expose an employee to other hazards not controlled by the standard involved.

Note to the definition of "high wind": The Occupational Safety and Health Administration 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.

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 Subpart V of this part.

Note to the definition of "host employer": The Occupational Safety and Health Administration 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, the Occupational Safety and Health Administration 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.

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.

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 subpart, uninsulated.

Insulation (cable). Material relied upon to insulate the conductor from other conductors or conducting parts or from ground.

Isolated. Not readily accessible to persons unless special means for access are used.

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:

1. For voltages to ground of 50 kilovolts or less-3.05 meters (10 feet);
2. 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.

Lines.

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

   Note 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.
2. *Electric supply lines.* Conductors used to transmit electric energy and their necessary supporting or containing structures. Signal lines of more than 400 volts are always supply lines within this subpart, and those of less than 400 volts are considered as supply lines, if so run and operated throughout.

Manhole. A subsurface enclosure that personnel may enter and that is used for installing, operating, and maintaining submersible equipment or cable.

Minimum approach distance. The closest distance an employee may approach an energized or a grounded object.

Note to the definition of "minimum approach distance": Paragraph (c)(1)(i) of §1926.960 requires employers to establish minimum approach distances.

Personal fall arrest system. A system used to arrest an employee in a fall from a working level.

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 §1926.950(b)(2) to be a qualified employee.

Note 2 to the definition of "qualified employee (qualified person)": Except under §1926.954(b)(3)(iii), 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.

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).

Switch. A device for opening and closing or for changing the connection of a circuit. In this subpart, a switch is manually operable, unless otherwise stated.

System operator. A qualified person designated to operate the system or its parts.

Vault. An enclosure, above or below ground, that personnel may enter and that is used for installing, operating, or maintaining equipment or cable.

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

Voltage. The effective (root mean square, or rms) potential difference between any two conductors or between a conductor and ground. This subpart 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.

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.

[79 FR 20715-20717, July 10, 2014; 79 FR 56962, September 24, 2014; 80 FR 25518, May 4, 2015]

APPENDIX A TO SUBPART V OF PART 1926
[RESERVED]

[79 FR 20717, July 10, 2014]

APPENDIX B
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 over-voltages impressed on the system. Conditions such as switching surges, faults, and lightning can cause over-voltages. 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 §§1926.960(c)(1) and 1926.964(c). Employers must use the technical criteria and methodology presented in this appendix in establishing minimum approach distances in accordance with §1926.960(c)(1)(i) and Table V-2 and Table V-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 over-voltages specified in Table V-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.

[1]Federal, State, and local regulatory bodies and electric utilities set reliability requirements that limit the number and duration of system outages.

II. General.

A. *Definitions*. The following definitions from §1926.968 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 subpart, 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 high-voltage systems. The employee must avoid contact with the exposed parts, and the protective equipment used (such as rubber insulating gloves) must provide insulation for the voltages involved.

C. *Exposed energized parts over 300 volts AC*. Paragraph (c)(1)(i) of §1926.960 requires the employer to establish minimum approach distances no less than the distances computed by Table V-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.

[2]Sparkover is a disruptive electric discharge in which an electric arc forms and electric current passes through air.

Normal system design may provide or include a means (such as lightning arrestors) to control maximum anticipated transient over-voltages, or the employer may use temporary devices (portable protective gaps) or measures (such as preventing automatic circuit breaker reclosing) to achieve the same result. Paragraph (c)(1)(ii) of §1926.960 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 V-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 over-voltages.

D. *Types of exposures*. Employees working on or near energized electric power generation, transmission, and distribution systems face two kinds of exposures: phase-toground 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 liveline 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)**
25	2
3	3
6	4
46	5
53	6
60	7
70	8
79	10
86	12
95	14
104	16
112	18
120	20
143	25
167	30
192	35
218	40
243	45
270	50
322	60

Source: IEEE Std 516-2009.

To use this table to determine the electrical component of the minimum approach distance, the employer 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.

[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 3σ point below the sparkover voltage, assuming that the sparkover curve follows a normal distribution.

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

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

Where:

D = Electrical component of the minimum approach distance in air in meters;

C = a correction factor associated with the variation of gap sparkover with voltage;

a = A factor relating to the saturation of air at system voltages of 345 kilovolts or higher;[4]

V_{L-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}

[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 over-voltages exceeding 630 kilovolts. Table R-3 sets equations for calculating a based on peak voltage.

Table 3
Equations for Calculating the Surge Factor, *a*

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
a	0	$(V_{Peak}-635)/140{,}000$	$(V_{Peak}-645)/135{,}000$
$V_{Peak}=T_{L-G}V_{L-G}\sqrt{2}$	More than 1,050 kV		
a	$(V_{Peak}-675)/125{,}000$		
Phase-to-Phase Exposures[1]			
$V_{Peak}=(1.35T_{L-G}+0.45)V_{L-G}\sqrt{2}$	630 kV or less	630.1 to 848 kV	848.1 to 1,131 kV
A	0	$(V_{Peak}-630)/155{,}000$	$(V_{Peak}-633.6)/152{,}207$
$V_{Peak}=(1.35T_{L-G}+0.45)V_{L-G}\sqrt{2}$	1,131 to 1,485 kV	More than 1,485 kV	
A	$(V_{Peak}-628)/153{,}846$	$(V_{Peak}-350.5)/203{,}666$	
[1]Use the equations for phase-to-ground exposures (with V_{Peak} for phase-to-phase exposures) unless the employer can demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap.			

In Equation 1, T is the maximum transient overvoltage factor in per unit. As noted earlier, §1926.960(c)(1)(ii) 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 V-8. For phase-to-ground exposures, the employer uses this value, called T_{L-G}, as T in Equation 1. IEEE Std 516-2009 provides the following formula to calculate the phase-to-phase maximum transient overvoltage, T_{L-L}, from T_{L-G}:

$$T_{L-L} = 1.35T_{L-G} + 0.45.$$

For phase-to-phase exposures, the employer uses this value as T in Equation 1.

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 subpart adopts an ergonomic component of the minimum approach distance of 0.31 m (1 foot) for voltages between 72.6 and 800 kilovolts.

[5]For voltages of 50 to 300 volts, Table V-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.

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 §1926.950, and the job planning and briefing required under §1926.952, must address selection of a proper working position.

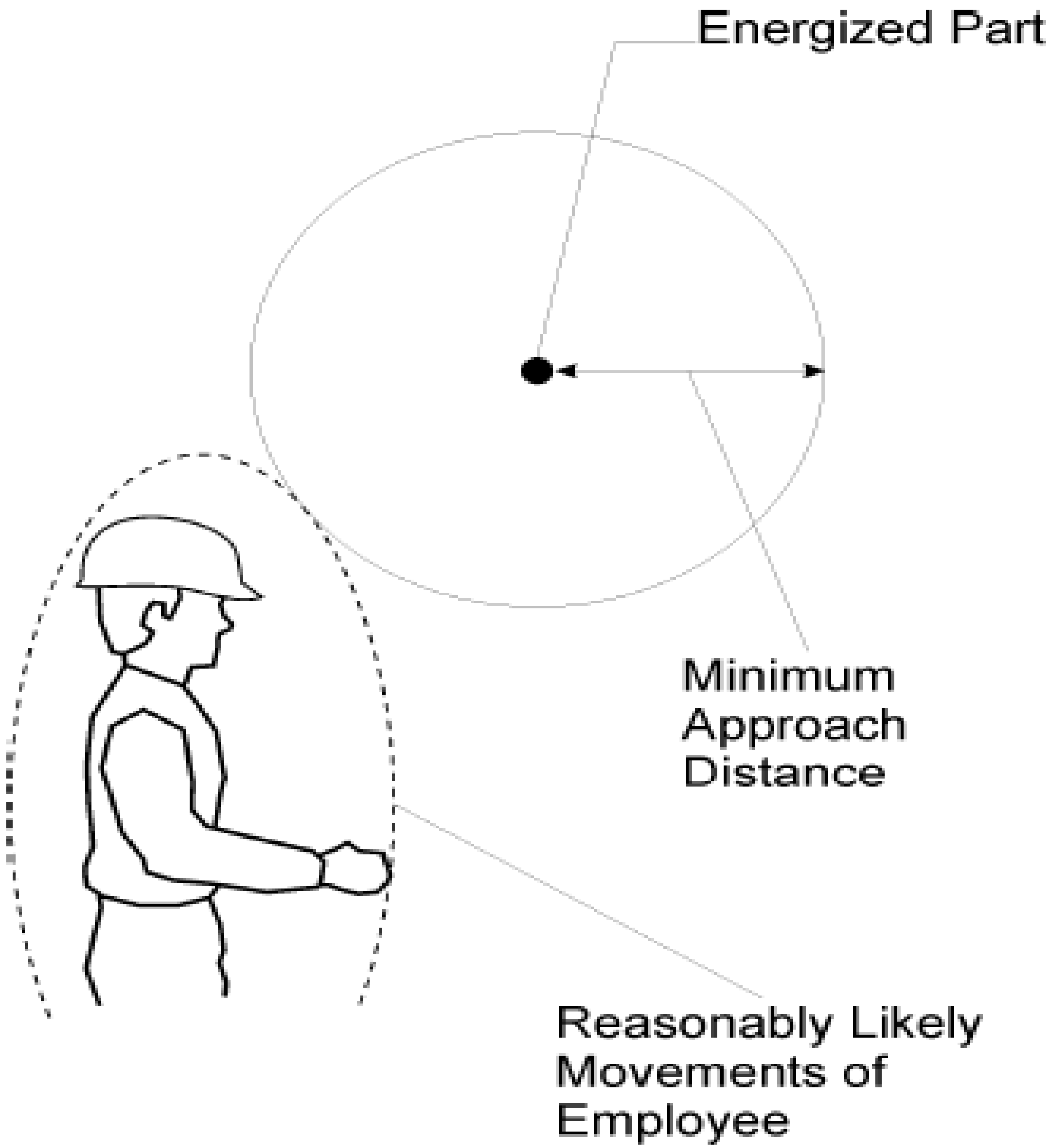

Figure 1 – Maintaining the Minimum Approach Distance

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.

[6]For the purposes of estimating arc length, Subpart V 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.

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 V-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 V-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 per-unit calculations.

2. *Transient over-voltages*. Operation of switches or circuit breakers, a fault on a line or circuit or on an adjacent circuit, and similar activities may generate transient over-voltages 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 over-voltages found on electric power generation, transmission, and distribution systems. The equations in Table V-2 for minimum approach distances use per-unit maximum transient over-voltages, 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 over-voltages*. Table 5 lists the magnitude of typical transient over-voltages.

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 (3σ) 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 §1926.968 depends on the maximum overvoltage possible at the worksite.

B. *Minimum approach distances based on known, maximum-anticipated per-unit transient over-voltages*.

1. *Determining the minimum approach distance for AC systems*. Under §1926.960(c)(1)(ii), 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-toground, in accordance with Table V-8. When the employer conducts an engineering analysis of the system and determines that the maximum transient overvoltage is lower than specified by Table V-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 live-work 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 over-voltages) 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 3σ . 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 V-2.

C. *Methods of controlling possible transient overvoltage stress found on a system*.

1. *Introduction*. There are several means of controlling over-voltages that occur on transmission systems. For example, the employer can modify the operation of circuit breakers or other switching devices to reduce switching transient over-voltages. 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 over-voltages.

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 over-voltages 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 live-work activity.

[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.

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 (V_{PPG} *Peak*).

Step 4. Determine the maximum transient overvoltage, phase-to-ground, at the worksite from the following formula:

$$T = \frac{V_{PPGPeak}}{V_{L\text{-}G}\sqrt{2}}$$

Step 5. Use this value of *T*[12] in the equation in Table V-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 7 through Table 14.

Note: All rounding must be to the next higher value (that is, always round up).

[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.

Sample protective gap calculations.

Problem: Employees are to perform work on a 500-kilovolt transmission line at sea level that is subject to transient over-voltages 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:
$561kV \div 0.85 = 660kV$
For example, if a protective gap with a 1.22-m (4.0-foot) spacing tested to a critical sparkover voltage of 665 kilovolts (crest), select this gap spacing.

Step 3. The phase-to-ground peak voltage at gap sparkover ($V_{PPG\ Peak}$) is 110 percent of the value from the previous step:
$665kV \times 1.10 = 732kV$
This value corresponds to the withstand voltage of the electrical component of the minimum approach distance.

Step 4. Use this voltage to determine the worksite value of *T*:
$T = \frac{732}{564} = 1.7\ p.u.$

Step 5. Use this value of *T* in the equation in Table V-2 to obtain the minimum approach distance, or look up the minimum approach distance in Table 7 through Table 14:
MAD = 2.29m(7.6 ft).

[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.

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 V-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 over-voltages 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. *Legacy tables*.

Employers may use the minimum approach distances in Table 6 until March 31, 2015.

TABLE 6
MINIMUM APPROACH DISTANCES UNTIL MARCH 31, 2015

Voltage range phase to phase (kV)	Phase-to-ground exposure		Phase-to-ground exposure	
	m	ft	m	ft
2.1 to 15.0	0.64	2.1	0.61	2.0
15.1 to 35.0	0.71	2.3	0.71	2.3
35.1 to 46.0	0.76	2.5	0.76	2.5
46.1 to 72.5	0.91	3.0	0.91	3.0
72.6 to 121	1.02	3.3	1.37	4.5
138 to 145	1.07	3.5	1.52	5.0
161 to 169	1.12	3.7	1.68	5.5
230 to 242	1.52	5.0	2.54	8.3
345 to 362 *	2.13	7.0	4.06	13.3
500 to 552 *	3.35	11.0	6.10	20.0
700 to 765 *	4.57	15.0	9.45	31.0
Note: The clear live-line tool distance must equal or exceed the values for the indicated voltage ranges.				

B. *Alternative minimum approach distances*.

Employers may use the minimum approach distances in Table 7 through Table 14 provided that the employer follows the notes to those tables.

TABLE 7
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	3.0	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 8 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	1.085	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 9 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 10 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	4.4
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	10.0

TABLE 11 AC MINIMUM APPROACH DISTANCES-242.1 TO 362.0 KV				
T (p.u.)	**Phase-to-ground exposure**		**Phase-to-ground exposure**	
	m	**ft**	**m**	**ft**
1.5	1.37	4.5	1.99	6.5
1.6	1.44	4.7	2.13	7.0
1.7	1.51	5.0	2.27	7.4
1.8	1.58	5.2	2.41	7.9
1.9	1.65	5.4	2.56	8.4
2.0	1.72	5.6	2.71	8.9
2.1	1.79	5.9	2.87	9.4
2.2	1.87	6.1	3.03	9.9
2.3	1.97	6.5	3.20	10.5
2.4	2.08	6.8	3.37	11.1
2.5	2.19	7.2	3.55	11.6
2.6	1.29	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 12 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	2.34	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	3.97	10.0	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 13 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 14 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	3.36	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	22.3	11.38	37.3

Notes to Table 7 through Table 14:

1. The employer must determine the maximum anticipated per-unit transient overvoltage, phase-to-ground, through an engineering analysis, as required by §1926.960(c)(1)(ii), or assume a maximum anticipated per-unit transient overvoltage, phase-to-ground, in accordance with Table V-8.

2. For phase-to-phase exposures, the employer must demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap. 3. The worksite must be at an elevation of 900 meters (3,000 feet) or less above sea level.

3. the worksite must be at an elevation of 900 meters (3,000 feet) or less above sea level.

[79 FR 20717-20728, July 10, 2014; 79 FR 56962, September 24, 2014]

APPENDIX C
PROTECTION FROM HAZARDOUS DIFFERENCES IN ELECTRIC POTENTIAL

I. Introduction.

Current passing through an impedance impresses voltage across that impedance. Even conductors have some, albeit low, value of impedance. Therefore, if a "grounded"[1] object, such as a crane or deenergized and grounded power line, results in a ground fault on a power line, voltage is impressed on that grounded object. The voltage impressed on the grounded object depends largely on the voltage on the line, on the impedance of the faulted conductor, and on the impedance to "true," or "absolute," ground represented by the object. If the impedance of the object causing the fault is relatively large, the voltage impressed on the object is essentially the phase-to-ground system voltage. However, even faults to grounded power lines or to well-grounded transmission towers or substation structures (which have relatively low values of impedance to ground) can result in hazardous voltages.[2] In all cases, the degree of the hazard depends on the magnitude of the current through the employee and the time of exposure. This appendix discusses methods of protecting workers against the possibility that grounded objects, such as cranes and other mechanical equipment, will contact energized power lines and that deenergized and grounded power lines will become accidentally energized.

[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.

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).

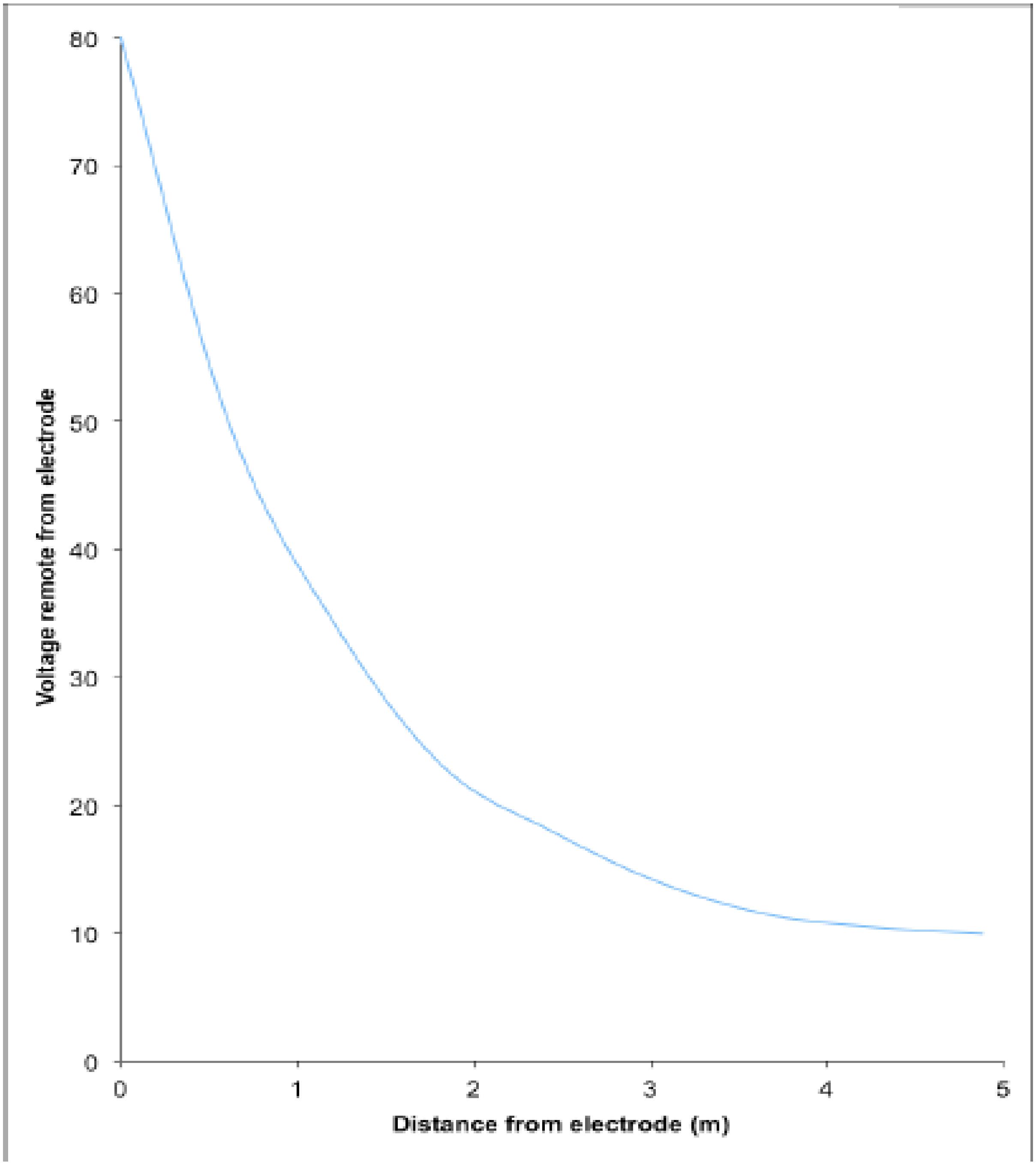

Figure 1 – Typical Voltage-Gradient Distribution Curve

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.

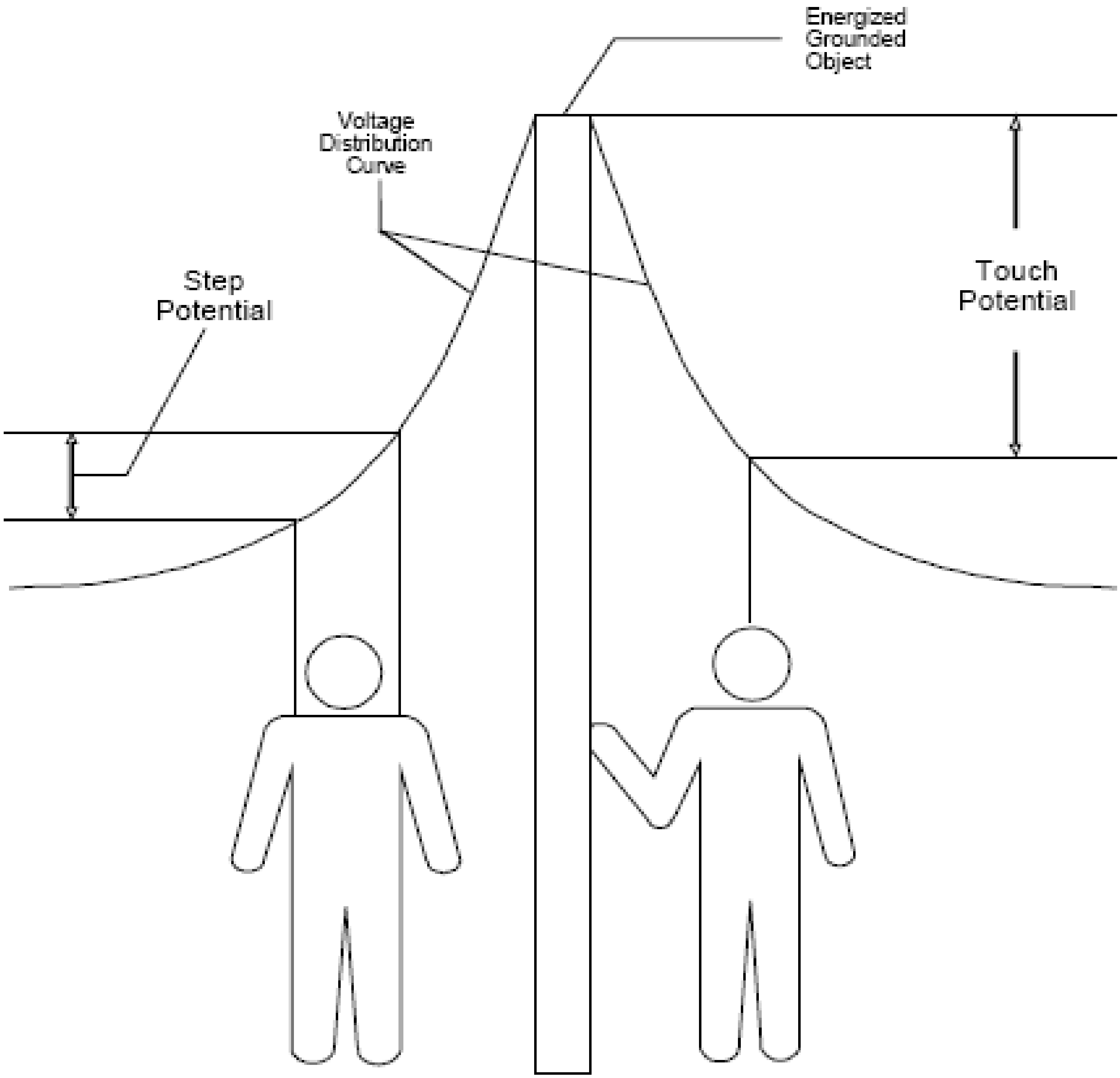

Figure 2 – Step and Touch Potentials

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.

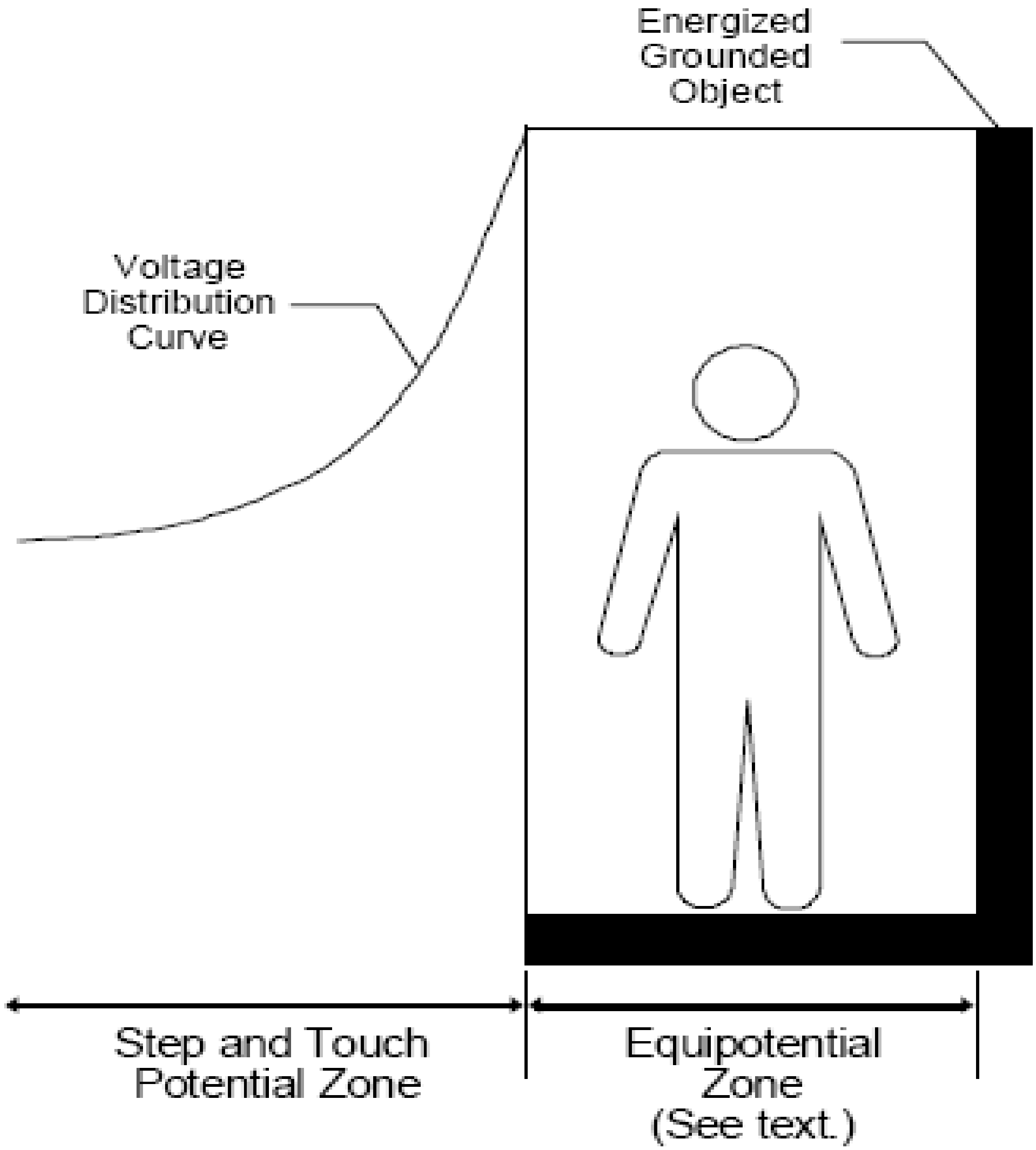

Figure 3 – Protection from Ground-Potential Gradients

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 §1926.962 for using protective grounding to protect employees working on deenergized power lines. Section 1926.962 applies to grounding of transmission and distribution lines and equipment for the purpose of protecting workers. Paragraph (c) of §1926.962 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 §1926.962(c). 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 §1926.962(c). The Occupational Safety and Health Administration will consider employers that comply with the criteria in this appendix as meeting §1926.962(c).

Finally, Section III.D.3 of this appendix discusses other safety considerations that will help the employer comply with other requirements in §1926.962. Following these guidelines will protect workers from hazards that can occur when a deenergized and grounded line becomes energized.

[3]The protective grounding required by §1926.962 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.

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 §1926.962(c).

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]).

[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.

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 §1926.962(c) 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.

Paragraph (c) of §1926.962 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 §1926.962(c).

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.

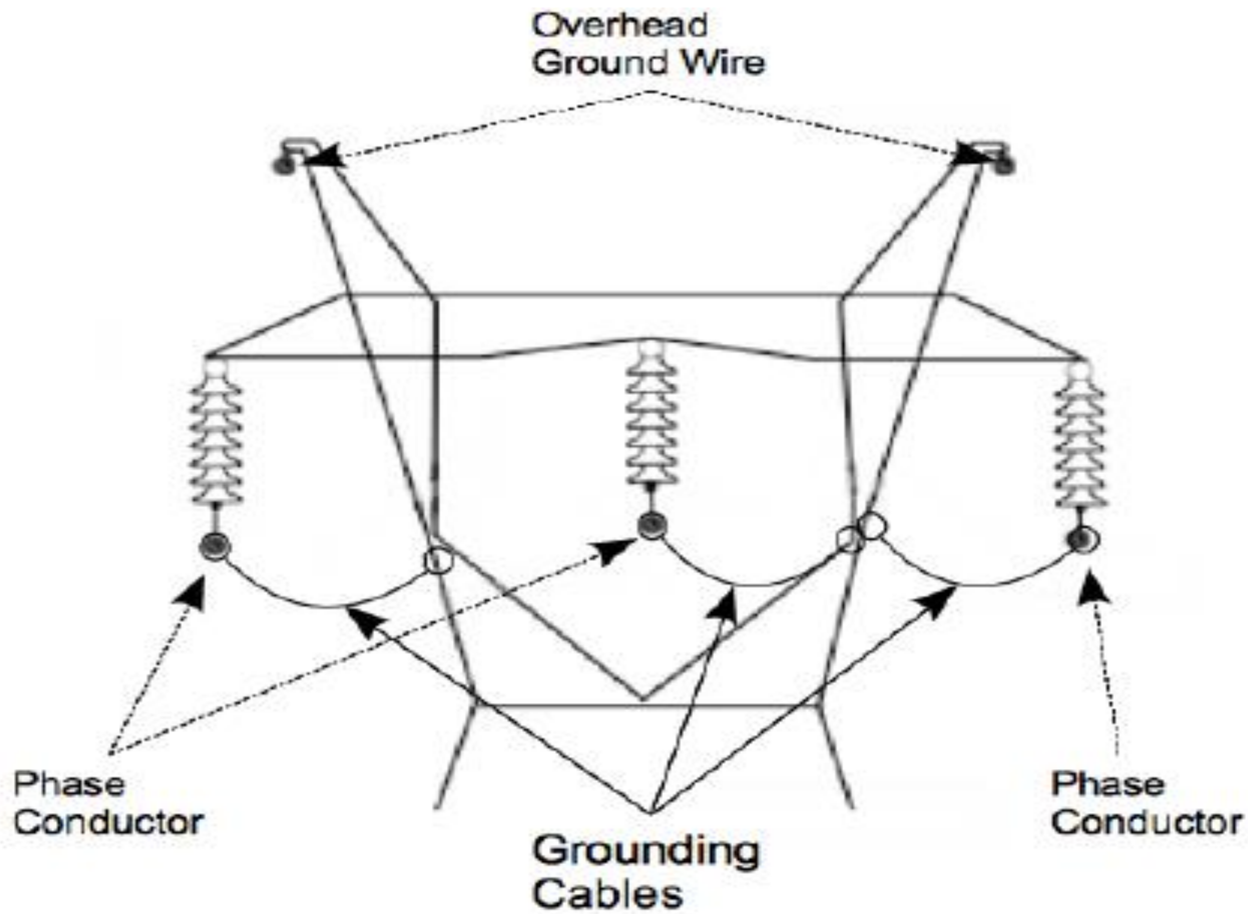

Figure 4 – Equipotential Zone for Metal Lattice Tower

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.

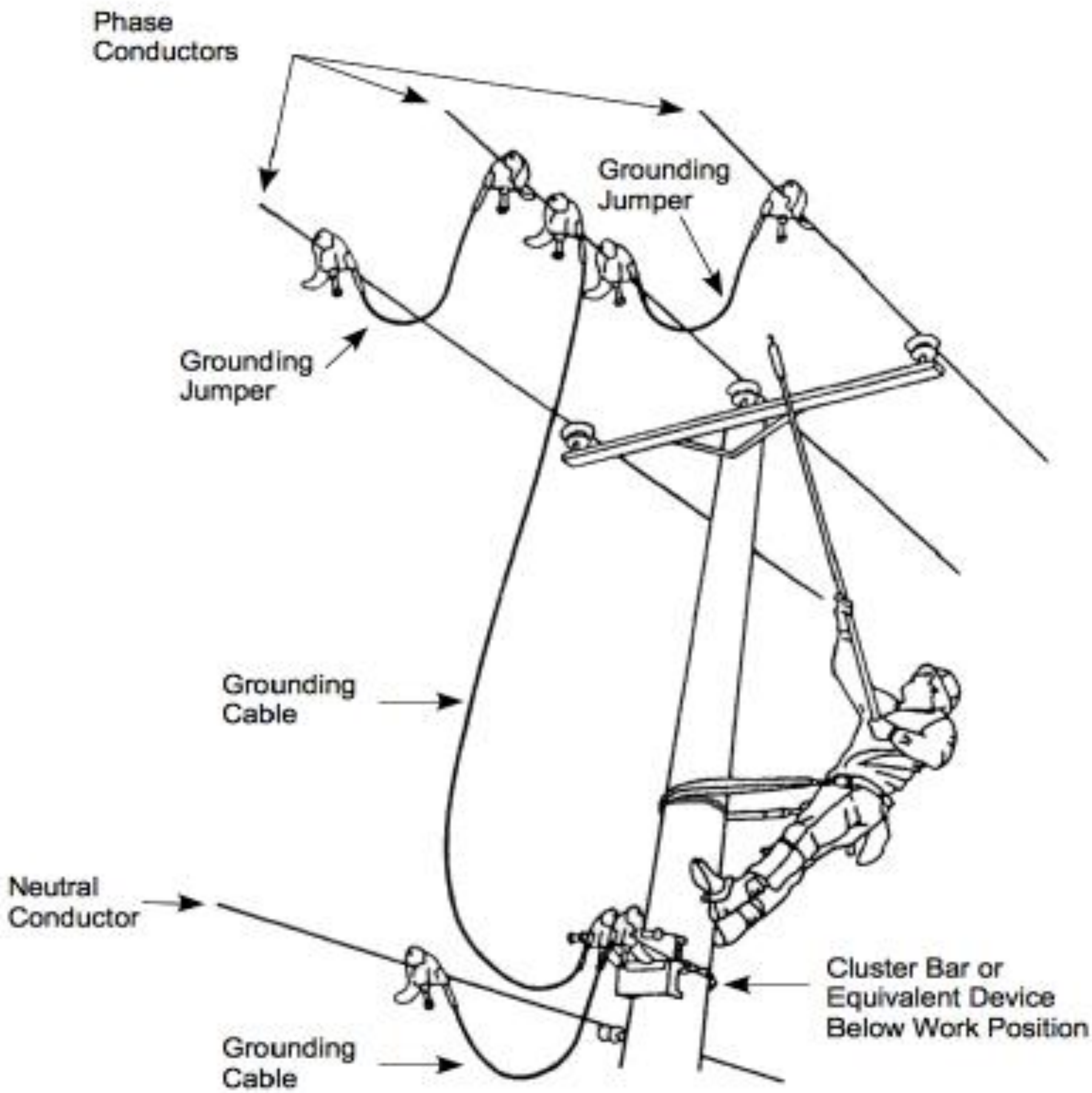

Figure 5 – Equipotential Ground for Wood Poles

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.

[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 §1926.962(d)(1)(i). IEEE Std 1048-2003 contains guidelines for selecting and installing grounding equipment that will meet §1926.962(d)(1)(i).

[79 FR 20728-20736, July 10, 2014]

APPENDIX D
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.

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

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.

[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.

III. Testing wood poles.

The following tests, which are from §1910.268(n)(3) of this chapter, 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.

[79 FR 20736, July 10, 2014]

APPENDIX E
PROTECTION FROM FLAMES AND ELECTRIC ARCS

I. Introduction.

Paragraph (g) of §1926.960 addresses protecting employees from flames and electric arcs. This paragraph requires employers to: (1) assess the workplace for flame and electric-arc hazards (paragraph (g)(1)); (2) estimate the available heat energy from electric arcs to which employees would be exposed (paragraph (g)(2)); (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 (g)(3)); 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 (g)(4) and (g)(5)). This appendix contains information to help employers estimate available heat energy as required by §1926.960(g)(2), select protective clothing and other protective equipment with an arc rating suitable for the available heat energy as required by §1926.960(g)(5), and ensure that employees do not wear flammable clothing that could lead to burn injury as addressed by §§1926.960(g)(3) and (g)(4).

[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*.)

II. Assessing the workplace for flame and electric-arc hazards.

Paragraph (g)(1) of §1926.960 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. The Occupational Safety and Health Administration 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 §1926.960(c)(1)(iii)).

• Whether the operation of electric equipment with sliding parts that could fault during operation is part of the normal operation of the equipment or occurs during servicing or maintenance, and

• For energized electric equipment, whether there is evidence of impending failure, such as evidence of arcing or overheating.

B. *Examples*.
Table 1 provides task-based examples of exposure assessments.

Table 1
EXAMPLE ASSESSMENT FOR VARIOUS TASKS

Task		Is Employee Exposed to Flame or Electric-Arc Hazard ?
Normal operation of enclosed equipment, such as closing or opening a switch.	The employer properly installs and maintains enclosed equipment, and there is no evidence of impending failure.	**No**
	There is evidence of arcing or overheating	**Yes**
	Parts of the equipment are loose or sticking, or the equipment otherwise exhibits signs of lack of maintenance.	**Yes**
Servicing electric equipment, such as racking in a circuit breaker or replacing a switch		**Yes**
Inspection of electric equipment with exposed energized parts.	The employee is not holding conductive objects and remains outside the minimum approach distance established by the employer.	**No**
	The employee is holding a conductive object, such as a flashlight, that could fall or otherwise contact energized parts (irrespective of whether the employee maintains the minimum approach distance).	**Yes**
	The employee is closer than the minimum approach distance established by the employer (for example, when wearing rubber insulating gloves or rubber insulating gloves and sleeves).	**Yes**
Using open flames, for example, in wiping cable splice sleeves		**Yes**

III. Protection against burn injury.

A. *Estimating available heat energy*.

Calculation methods. Paragraph (g)(2) of §1926.960 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. The Occupational Safety and Health Administration 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	N[3]	N[3]	N[3]
Doughty, Neal, and Floyd	Y-C	Y	Y	N	N	N	N	N	N
IEEE Std 1584b-2011	Y	Y	Y	Y	Y	Y	N	N	N
ARCPRO	Y	N	N	Y	N	N	Y	Y[4]	Y[4]

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 Occupational Safety and Health Administration will consider these methods reasonable for enforcement purposes when employers use the methods in accordance with this table, employers should be aware that the listed methods do not necessarily result in estimates that will provide full protection from internal faults in transformers and similar equipment or from arcs in underground manholes or vaults.

[2] At these voltages, the presumption is that the arc is three-phase unless the employer can demonstrate that only one phase is present or that the spacing of the phases is sufficient to prevent a multiphase arc from occurring.

[3] Although the Occupational Safety and Health Administration will consider this method acceptable for purposes of assessing whether incident energy exceeds 2.0 cal/cm^2, the results at voltages of more than 15 kilovolts are extremely conservative and unrealistic.

[4] The Occupational Safety and Health Administration 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. The Occupational Safety and Health Administration 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 and live-line barehand work	MAD−(2×*kV*×2.54)	NA
	MAD−(2×*kV*/10)) †	

*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 spacings.
Single conductor in air, more than 15 kV	Voltage in kV × 2.54	Phase conductor spacings.
	(Voltage in kV × 0.1), but no less than 51 mm (2 inches)	
[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. Paragraph (g)(2) of §1926.960 permits the employer to make broad estimates that cover multiple system areas provided that: (1) the employer uses reasonable assumptions about the energy exposure distribution throughout the system, and (2) the estimates represent the maximum exposure for those areas. For example, the employer can use the maximum fault current and clearing time to cover several system areas at once.

Incident heat energy for single-phase-to-ground exposures. Table 6 and Table 7 provide incident heat energy levels for open-air, phase-to-ground electric-arc exposures typical for overhead systems.[2] Table 6 presents estimates of available energy for employees using rubber insulating gloves to perform work on overhead systems operating at 4 to 46 kilovolts. The table assumes that the employee will be 380 millimeters (15 inches) from the electric arc, which is a reasonable estimate for rubber insulating glove work. Table 6 also assumes that the arc length equals the sparkover distance for the maximum transient overvoltage of each voltage range.[3] To use the table, an employer would use the voltage, maximum fault current, and maximum clearing time for a system area and, using the appropriate voltage range and fault-current and clearing-time values corresponding to the next higher values listed in the table, select the appropriate heat energy (4, 5, 8, or 12 cal/cm^2) from the table. For example, an employer might have a 12,470-volt power line supplying a system area. The power line can supply a maximum fault current of 8 kiloamperes with a maximum clearing time of 10 cycles. For rubber glove work, this system falls in the 4.0-to-15.0-kilovolt range; the next-higher fault current is 10 kA (the second row in that voltage range); and the clearing time is under 18 cycles (the first column to the right of the fault current column). Thus, the available heat energy for this part of the system will be 4 cal/cm^2 or less (from the column heading), and the employer could select protection with a 5-cal/cm^2 rating to meet §1926.960(g)(5). Alternatively, an employer could select a base incident-energy value and ensure that the clearing times for each voltage range and fault current listed in the table do not exceed the corresponding clearing time specified in the table. For example, an employer that provides employees with arc-flash protective equipment rated at 8 cal/cm^2 can use the table to determine if any system area exceeds 8 cal/cm^2 by checking the clearing time for the highest fault current for each voltage range and ensuring that the clearing times do not exceed the values specified in the 8-cal/cm^2 column in the table.

[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.

Table 7 presents similar estimates for employees using live-line tools to perform work on overhead systems operating at voltages of 4 to 800 kilovolts. The table assumes that the arc length will be equal to the sparkover distance[4] and that the employee will be a distance from the arc equal to the minimum approach distance minus twice the sparkover distance.

The employer will need to use other methods for estimating available heat energy in situations not addressed by Table 6 or Table 7. The calculation methods listed in Table 2 and the guidance provided in Table 3 will help employers do this. For example, employers can use IEEE Std 1584b-2011 to estimate the available heat energy (and to select appropriate protective equipment) for many specific conditions, including lower-voltage, phase-to-phase arc, and enclosed arc exposures.

[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-toground voltage in kilovolts multiplied by 2.54 (or voltage (in kilovolts) x 2.54).

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/cm²	5 cal/cm²	8 cal/cm²	12 cal/cm²
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 this subpart), 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

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
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 this subpart). 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.

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/cm²	**5 cal/cm²**	**8 cal/cm²**	**12 cal/cm²**
#For voltages of more than 72.6 kV, employers may use this table only when the minimum approach distance established under §1926.960(c)(1) 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 kV1.72 m 242.1 to 362.0 kV2.76 m 362.1 to 420.0 kV2.50 m 420.1 to 550.0 kV3.62 m 550.1 to 800.0 kV4.83 m					
**The voltage range is the phase-to-phase system voltage.					

B. *Selecting protective clothing and other protective equipment*.

Paragraph (g)(5) of §1926.960 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 §1926.960(g)(2). Based on laboratory testing required by ASTM F1506-10a, the expectation is that protective clothing with an arc rating equal to the estimated incident heat energy will be capable of preventing second-degree burn injury to an 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 §1926.960(g)(5) 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 §1926.960(g)(5) will provide an appropriate degree of protection for an employee exposed to electric-arc hazards.

[5]ASTM F1506-10a defines "arc thermal performance value" as "the incident energy on a material or a multilayer system of materials that results in a 50 % probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn injury based on the Stoll [footnote] curve, cal/cm^2." The footnote to this definition reads: "Derived from: Stoll, A. M., and Chianta, M. A., 'Method and Rating System for Evaluations of Thermal Protection,' Aerospace Medicine, Vol 40, 1969, pp. 1232-1238 and Stoll, A. M., and Chianta, M. A., 'Heat Transfer through Fabrics as Related to Thermal Injury,' Transactions—New York Academy of Sciences, Vol 33(7), Nov. 1971, pp. 649-670."

Paragraph (g)(5) of §1926.960 does not require arc-rated protection for exposures of 2 cal/cm^2 or less. Untreated cotton clothing will reduce a 2-cal/cm^2 exposure below the 1.2- to 1.5-cal/cm^2 level necessary to cause burn injury, and this material should not ignite at such low heat energy levels. Although §1926.960(g)(5) does not require clothing to have an arc rating when exposures are 2 cal/cm^2 or less, §1926.960(g)(4) requires the outer layer of clothing to be flame resistant under certain conditions, even when the estimated incident heat energy is less than 2 cal/cm^2, as discussed later in this appendix. Additionally, it is especially important to ensure that employees do not wear undergarments made from fabrics listed in the note to §1926.960(g)(3) 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 §1926.960(g)(3), (g)(4), or (g)(5).

Paragraph (g)(5) of §1926.960 requires that arc-rated protection cover the employee's entire body, with limited exceptions for the employee's hands, feet, face, and head. Paragraph (g)(5)(i) of §1926.960 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)

Paragraph (g)(5)(ii) of §1926.960 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, §1926.960(g)(5)(iii), (g)(5)(iv), and (g)(5)(v) require arc-rated head and face protection as follows:

MINIMUM HEAD AND FACE PROTECTION			
Exposure	**None"**	**Arc-Rated Faceshield with 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 §1910.135 or §1926.100(b)(2), as applicable.			
†The arc rating must be a minimum of 4 cal/cm^2 less than the estimated incident energy. Note that §1926.960(g)(5)(v) permits this type of head and face protection, with a minimum arc rating of 4 cal/cm^2 less than the estimated incident energy, at any incident energy level.			
‡Note that §1926.960(g)(5) permits this type of head and face protection at any incident energy level.			

IV. Protection against ignition.

Paragraph (g)(3) of §1926.960 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 §1926.960(g)(2). 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.

Paragraph (g)(5) of §1926.960 generally requires protective clothing and other protective equipment with an arc rating greater than or equal to the employer's estimate of available heat energy. As explained earlier in this appendix, untreated cotton is usually acceptable for exposures of 2 cal/cm^2 or less.[6] If the exposure is greater than that, the employee generally must wear flame-resistant clothing with a suitable arc rating in accordance with §1926.960(g)(4) and (g)(5). 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 §1926.960(g)(3), 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.

[6]See §1926.960(g)(4)(i), (g)(4)(ii), and (g)(4)(iii) 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/cm^2.

Under §1926.960(g)(3), 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/cm^2, §1926.960(g)(4) requires flame-resistant clothing when: the employee is exposed to contact with energized circuit parts operating at more than 600 volts (§1926.960(g)(4)(i)), an electric arc could ignite flammable material in the work area that, in turn, could ignite the employee's clothing (§1926.960(g)(4)(ii)), and molten metal or electric arcs from faulted conductors in the work area could ignite the employee's clothing (§1926.960(g)(4)(iii)). 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 §1926.960(g)(4)(iii).

[7]Paragraph (g)(3) of §1926.960 prohibits clothing that could ignite and continue to burn when exposed to the heat energy estimated under paragraph (g)(2) of that section.

[8]Breakopen occurs when a hole, tear, or crack develops in the exposed fabric such that the fabric no longer effectively blocks incident heat energy.

[9]Static wires and pole grounds are examples of grounding conductors that might not be capable of carrying fault current without failure. Grounds that can carry the maximum available fault current are not a concern, and employers need not consider such grounds a possible electric arc source.

[79 FR 20736-20742, July 10, 2014]

APPENDIX F
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.

[79 FR 20742, July 10, 2014]

APPENDIX G
REFERENCE DOCUMENTS

The references contained in this appendix provide information that can be helpful in understanding and complying with the requirements contained in Subpart V of this part. The national consensus standards referenced in this appendix contain detailed specifications that employers may follow in complying with the more performance-based requirements of Subpart V of this part. Except as specifically noted in Subpart V of this part, however, the Occupational Safety and Health Administration will not necessarily deem compliance with the national consensus standards to be compliance with the provisions of Subpart V of this part.

NATIONAL CONSENSUS STANDARDS	
Number & Edition	**Name**
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*.

NATIONAL CONSENSUS STANDARDS	
Number & Edition	**Name**
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 F887-12e1	*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*.

NATIONAL CONSENSUS STANDARDS	
Number & Edition	**Name**
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 $^{\varepsilon 1}$	*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*.

NATIONAL CONSENSUS STANDARDS	
Number & Edition	**Name**
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*.

[79 FR 20742-20743, July 10, 2014]

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